PATENT ABSTRACTS OF JAPAN

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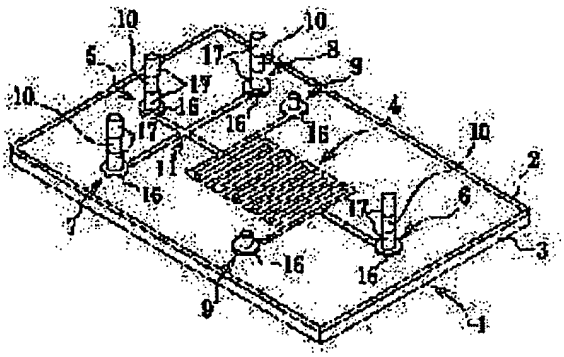
(54) ELECTROPHORETIC ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an electrophoretic element for machinery analysis capable of being enhanced in separation efficiency and reduced in size and having a surface modified inner wall high in durability.
SOLUTION: In an electrophoretic element 1, an injection flow channel crosses a separation column and at least a part of the inner surface of the separation column has a surface having zeta potential different from that of the inner surface of the injection flow channel. Since the electroosmotic flow of the injection flow channel is fast, a reagent is introduced for a short time and prevented from separation before introduced into a column, and separation efficiency can be enhanced by delaying the electroosmotic flow only in the separation column. The electrophretic element 1 can provide a fluid flow channel for machinery analysis capable of enhancing separation efficiency by reducing the absolute value of the zeta potential only of the separation column. Further, the electrophoretic element 1 can be formed by applying semiconductor process technique and a fine flow channel can be miniaturized.



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CLAIMS

[Claim(s)]
[Claim 1] In the electrophoresis component which constituted two or more liquid flow channels for the plate which carried out recessing in piles The passage section for impregnation which injects into this separation component the sample separated with this electrophoresis component at least, The electrophoresis component which is an electrophoresis component of which the separation column section which separates this sample crosses and consists, and is characterized by this a part of separation column section inside [at least] having the front face of different F-potential from the F-potential of this passage section inside for impregnation.
[Claim 2] The electrophoresis component which is an electrophoresis component of which the separation column section which separates a sample with this electrophoresis component at least, and the passage section for preparative isolation which isolates this separated sample preparatively cross and consist in an electrophoresis component according to claim 1, and is characterized by for a part of this separation column section inside [at least] to have the front face of different F-potential from the F-potential of this passage inside for preparative isolation.
[Claim 3] The electrophoresis component characterized by to have the front face of F-potential where it is the electrophoresis component which has two or more these passage sections for preparative isolation in an electrophoresis component according to claim 2, this at least one passage section for preparative isolation is constituted by the location of the arbitration of this separation column section, and a part of [at least] F-potential of the separation column section inside of both ends differs from the F-potential of this passage inside for preparative isolation bordering on this style **** for preparative isolation.
[Claim 4] The electrophoresis component characterized by preparing the passage section for electrical-potential-difference impression in the passage section side for impregnation of the separation column section inserted into two or more passage sections for preparative isolation in an electrophoresis component according to claim 3.
[Claim 5] In the electrophoresis component which constituted two or more liquid flow channels for the plate which carried out recessing in piles The passage section for impregnation which injects into this separation component the sample separated with this electrophoresis component at least, It is the electrophoresis component of which the separation column section which separates this sample crosses and consists. It has the

front face of F-potential where this a part of separation column section inside [at least] differs from the F-potential of the substrate passage inside which carried out recessing. The electrophoresis component to which the front face of different F-potential from the F-potential of the substrate which carried out recessing is characterized by being constituted with the insulating inorganic material.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] About an electrophoresis component, especially this invention is applied to the fluid passage for instrumental analyses, and relates to the suitable electrophoresis component for instrumental analyses.
[0002]
[Description of the Prior Art] Fluid passage for instrumental analyses is conventionally performed using capillaries, such as glass and stainless steel. In order that this capillary might raise analysis capacity, the capillary with a die length of 50cm was usually used, and since the capillary of this die length was used rounding off it in the shape of a circle, the miniaturization was difficult. Moreover, the conventional fluid passage for instrumental analyses was impossible for performing surface treatment partially, since it consists of one capillary although surface treatment is performed for the purpose of the improvement in separability.
[0003] As a means to solve the above-mentioned technical problem, a means to constitute a detailed slot on a silicon wafer, glass, etc. is reported by the semi-conductor process technique. For example, a slot is processed into silicon or a glass substrate, a liquid flow channel is formed in JP,9-89840,A (reference 1), and the small electrophoresis apparatus which embellishes the passage with the request matter partially, and enabled it to perform high sensitivity analysis efficiently is reported to it.
[0004] Drawing 18 shows ****** of this electrophoresis apparatus. A sign 106 expresses passage for liquid route opening which can present the liquid flow close and the business of an outflow with signs 101, 102, 103, and 105,108,109,110 among drawing again. By etching, this electrophoresis apparatus forms a slot (passage 106) in one substrate 117, joins the substrate (un-illustrating) of another side, and forms the component. The inflow and the tap hole of the liquid for pouring liquid partially are established in on the way (reference mark 107,112 part) (in the example of illustration, the group of an inflow and tap holes 101,109 and 102,108 is arranged), and the liquid flow channel 106 which consists of the slot of a substrate 117 is constituted so that a surface qualification agent may be passed partially and the surface qualification of the passage wall can be carried out partially.
[0005] Various silane coupling agents are used as a surface qualification agent, an affinity with the separation matter can be changed and separation efficiency can be made to

superimpose according to the class of induction radical which silane coupling agent has. It is reported by this surface qualification that high sensitivity analysis can be performed efficiently.

[0006]

[Problem(s) to be Solved by the Invention] In the above-mentioned advanced technology, although the effectiveness of the high separation and efficient-izing by partial surface qualification is reported, the contents lack in concreteness, especially the concrete publication is not carried out about efficient-ization.

[0007] Moreover, since the surface qualification by the silane coupling agent uses organic coating, degradation of a coat arises by washing by the organic solvent or alkali, and it has in endurance the trouble of being scarce.

[0008] Therefore, it was made that this invention should solve the above-mentioned problem, and the purpose is in offering the electrophoresis component for instrumental analyses which can be miniaturized possible [high separation and efficient-izing]. Moreover, it is in offering the electrophoresis component for instrumental analyses which has a surface qualification wall with high endurance.

[0009]

[Means for Solving the Problem] The following electrophoresis components are offered by this invention. Namely, the plate which carried out recessing is set for the electrophoresis component which constituted two or more liquid flow channels in piles. The passage section for impregnation which injects into this separation component the sample separated with this electrophoresis component at least, The electrophoresis component which is an electrophoresis component of which the separation column section which separates this sample crosses and consists, and is characterized by this a part of separation column section inside [at least] having the front face of different F-potential from the F-potential of this passage section inside for impregnation is offered (claim 1).

[0010] "The plate which carried out recessing" in claim 1 is the gestalt (deformation of the gestalt of the 1st operation and the example of modification are included.) of desirable operation of the 1st of this invention here. It is below the same. Although a borosilicate glass substrate corresponds then, for example, a glass substrate, a silicon wafer, a plastic plate of other materials, etc. are included. In the gestalt of this 1st operation, although the slot which constitutes "the plate which carried out recessing" in claim 1 was formed, for example by wet etching, it can also form dry etching, machining, etc. by other technique. Moreover, it is not necessary to limit the configuration of the slot of the gestalt of the 1st operation to this configuration, and they may be other configurations. Moreover, although the slot was constituted from the 1st operation gestalt only in one substrate, it is also possible to constitute a slot also like the substrate side of another side. It is also possible for the number of the substrates which constitute a slot not to be limited, but to constitute a slot in piles two or more sheets. Moreover, the substrate which carried out penetration processing, and a raw plate can also be constituted in piles. When the depth of flute or width of face impresses an electrical potential difference, it is desirable the range which an electroendosmose style generates, and that it is specifically 150 micrometers or less. The passage to which "the passage section for impregnation which injects the sample to separate into this separation component" in claim 1 connects a sample exhaust port with the gestalt of the 1st

operation from a sample inlet corresponds. The passage to which "the separation column section which separates this sample" in claim 1 connects a support liquid exhaust port with the gestalt of the 1st operation from a support liquid inlet corresponds. With the gestalt of this 1st operation, as for "the F-potential of the passage section inside for impregnation" in claim 1, the F-potential on the front face of borosilicate glass corresponds, for example. "The front face of different F-potential from the F-potential of the passage section inside for impregnation" in claim 1 contains hydrophilic macromolecules, **********, etc., such as other general finishing agents, for example, other silane coupling agents, a carboxymethyl cellulose, and polyacrylamide, although the passage wall surface treatment was carried out [the wall] by trimethylchlorosilane, for example corresponds with the gestalt of this 1st operation.

[0011] An operation of the electrophoresis component according to this invention and effectiveness can be explained as follows. Although analyzed by filling an electrolytic solution as support liquid to a capillary tube in capillary electrophoresis, an electric double layer is formed between the electrolytic solutions which touch a capillary tube wall and this by this. If an electrical potential difference is impressed here, an electrolytic solution will move with a solvent and an electroendosmose style will arise. An electroendosmose style can be used as driving force to which the separated component ion is moved. The electroendosmose rate of flow upsilon is expressed with the following formula as relation of electric-field-strength E applied along with the dielectric constant epsilon of an electrolytic solution, coefficient of viscosity eta, F-potential xi, and a capillary tube. F-potential is a capillary tube wall and the potential difference of electrolytic solution tubing.

[Equation 1] upsilon=-(epsilon xi/eta) E .... (1)

[0012] F-potential xi -- the electric charge condition of a capillary tube wall -- setting -- positive/negative -- although any sign can be taken -- usually -- business -- on the glass front face used for a capillary tube, since it becomes negative, upsilon becomes forward, therefore an electroendosmose style goes to cathode from an anode plate.

[0013] The F-potential of the passage wall of the passage section for impregnation from which the electrophoresis component which follows this invention here serves as sample induction, and the passage which is committed as a separation column and by which surface treatment was carried out differs. The wall of the passage section for impregnation is a borosilicate glass front face, and the sign of F-potential serves as negative from a surface electric charge condition. On the other hand, since the wall of the passage by which surface treatment was carried out which works as a separation column is covered in the nonionic finishing agent, a surface electric charge becomes weak, and the absolute value of F-potential becomes small compared with a surface non-processed passage wall.

[0014] By the way, the speed of the electroendosmose style at the time of impressing an electrical potential difference from the above-mentioned (1) formula is so quick that the absolute value of F-potential is large. That is, the passage section for impregnation of a reagent will be quick, and the electroendosmose style of the electrophoresis component of this invention will have the late separation column section. Separation efficiency is bad, while there will be little analysis time amount and it will end, if an electroendosmose style is quick. If an electroendosmose style is stopped by surface treatment, although analysis time amount will become long, separation efficiency improves. This phenomenon

is explained to "Honda ***, Terabe **:capillary electrophoresis, and P26; Kodansha" (reference 2). Therefore, since the passage section for impregnation has the quick electroendosmose style, before being able to manage reagent installation in a short time and putting the electrophoresis component of this invention into a column, it prevents separation of a reagent, and it becomes possible [that only the separation column section makes an electroendosmose style late, and gathers separation efficiency]. That is, the electrophoresis component of this invention can offer the fluid passage for instrumental analyses in which high separation and efficient-izing are possible by making small the absolute value of the F-potential of only the separation column section. Moreover, since the electrophoresis component of this invention can apply and create a semi-conductor process technique so that it may indicate to the creation approach of the gestalt the 1st operation, the fluid passage for instrumental analyses which can miniaturize detailed passage can be offered.

[0015] In an electrophoresis component according to claim 1, the value of a part of [at least] F-potential of this separation column section inside and the value of this invention of the F-potential of this passage section inside for impregnation are 0 or the same sign again. As a configuration it is made smaller [a configuration] than the absolute value of the F-potential of this passage section inside for impregnation, the absolute value of a part of [at least] F-potential of this separation column section inside can carry out suitably (the 1st modification), and can acquire similarly the same operation effectiveness as the case where it is based on above-mentioned claim 1. In this case, the value of the F-potential of ** in passage in which surface treatment was carried out to "the value of a part of [at least] F-potential of a separation column section inside" by trimethylchlorosilane with the gestalt of the 1st operation corresponds. With "the value of the F-potential of the passage section inside for impregnation", the value of the F-potential of a borosilicate glass substrate corresponds with the gestalt of the 1st operation.

[0016] Moreover, it sets for the electrophoresis component of claim 1 (or the 1st modification) publication. It is the electrophoresis component of which the separation column section which separates a sample, and the passage section for preparative isolation which isolates this separated sample preparatively cross and consist with this electrophoresis component at least. The electrophoresis component characterized by this a part of separation column section inside [at least] having the front face of different F-potential from the F-potential of this passage inside for preparative isolation is offered by this invention (claim 2).

[0017] The passage which connects a support liquid exhaust port with the gestalt (deformation of the gestalt of the 2nd operation and the example of modification are included) of the 2nd operation of the after-mentioned to "the separation column section which separates a sample" in claim 2 from a support liquid inlet corresponds here. The passage which connects two preparative isolation openings with this 2nd operation gestalt to "the passage section for preparative isolation which isolates this separated sample preparatively" in claim 2 corresponds. With "the F-potential of the passage inside for preparative isolation" in claim 2, the F-potential on the front face of borosilicate glass corresponds with this 2nd operation gestalt, for example. With "the front face of different F-potential from the F-potential of the passage inside for preparative isolation" in claim 2, the passage wall surface treatment was carried out [the wall] by

trimethylchlorosilane, for example corresponds with this 2nd operation gestalt.
[0018] In the case of claim 2, in addition to an operation and effectiveness of an electrophoresis component according to claim 1, the electrophoresis component of this invention has the following operation and effectiveness. The F-potential of the passage wall of the passage which the electrophoresis component of this invention commits as a separation column and by which surface treatment was carried out, and the passage section for preparative isolation used for the aliquot of the separation matter differs. The wall of the passage section for preparative isolation is a borosilicate glass front face, and the sign of F-potential serves as negative from a surface electric charge condition. On the other hand, since the wall of the passage by which surface treatment was carried out which works as a separation column is covered in the nonionic finishing agent, a surface electric charge becomes weak, and the absolute value of F-potential becomes small compared with a surface non-processed passage wall.
[0019] Here, the speed of the electroendosmose style at the time of impressing an electrical potential difference from the aforementioned (1) formula is so quick that the absolute value of F-potential is large. That is, the passage section for preparative isolation will be quick, and the electrophoresis component of this invention will have the late separation column section. Separation efficiency is bad, while there will be little analysis time amount and it will end, if an electroendosmose style is quick. If an electroendosmose style is stopped by surface treatment, although analysis time amount will become long, separation efficiency improves. Therefore, it becomes possible only for the separation column section to make an electroendosmose style late, and, as for the electrophoresis component of this invention, to gather separation efficiency, to be able to perform an aliquot in a short time, since the passage section for preparative isolation has the quick electroendosmose style, and to prevent separation of a reagent before preparative isolation. That is, the electrophoresis component of this invention can offer the fluid passage for instrumental analyses in which high separation and efficient-izing are possible by making small the absolute value of the F-potential of only the separation column section. Moreover, since the electrophoresis component of this invention can apply and create a semi-conductor process technique, the fluid passage for instrumental analyses which can miniaturize detailed passage can be offered.
[0020] In an electrophoresis component according to claim 2, the value of a part of [at least] F-potential of this separation column section inside and the value of this invention of the F-potential of this passage section inside for preparative isolation are 0 or the same sign again. As a configuration it is made smaller [a configuration] than the absolute value of the F-potential of this passage section inside for preparative isolation, the absolute value of a part of [at least] F-potential of this separation column section inside can carry out suitably (the 2nd modification), and can acquire similarly the same operation effectiveness as the case where it is based on above-mentioned claim 2. In this case, the value of the F-potential of the passage wall in which surface treatment was carried out to "the value of a part of [at least] F-potential of a separation column section inside" by trimethylchlorosilane with the gestalt of the 2nd operation corresponds. With "the value of the F-potential of the passage section inside for preparative isolation", the value of the F-potential of a borosilicate glass substrate corresponds with the gestalt of the 2nd operation.
[0021] Moreover, it is the electrophoresis component which has two or more these

passage sections for preparative isolation in an electrophoresis component according to claim 2. This at least one passage section for preparative isolation is constituted by the location of the arbitration of this separation column section. The electrophoresis component to which a part of [at least] F-potential of the separation column section inside of both ends is characterized by having the front face of different F-potential from the F-potential of this passage inside for preparative isolation is offered by this invention bordering on this style **** for preparative isolation (claim 3).

[0022] Although the passage section for preparative isolation which crosses the center of the separation column section corresponds here with the gestalt (deformation of the gestalt of the 3rd operation and the example of modification are included) of the 3rd operation of the after-mentioned with "at least one passage section for preparative isolation constituted by the location of the arbitration of the separation column section" in claim 3 The crossing location is not limited but can constitute the location of the separation column section in the location of arbitration. Moreover, the number of the passage sections for preparative isolation constituted by the location of the arbitration of the separation column section is not limited, either. With the gestalt of this 3rd operation, as for "the F-potential of the passage inside for preparative isolation" in claim 3, the F-potential on the front face of borosilicate glass corresponds, for example. The passage wall with which surface treatment of the "front face of different F-potential from the F-potential of the passage inside for preparative isolation" in claim 3 was carried out by trimethylchlorosilane with the gestalt of this 3rd operation, for example corresponds. Moreover, it is also possible for the separation column of both ends to perform the same surface treatment bordering on this passage section for preparative isolation possible [making surface treatment from which each differs into F-potential which gives and is different].

[0023] In the case of claim 3, in addition to an operation and effectiveness of claim 1 and an electrophoresis component according to claim 2, the electrophoresis component of this invention has the following operation and effectiveness. The electrophoresis component of this invention has the 1st passage and 2nd passage which commit the center of the separation column section as a separation column bordering on the 1st crossing passage section for preparative isolation and by which surface treatment was carried out, and the 2nd passage section for preparative isolation used for the support liquid exhaust port side which serves as a migration end of the separation matter further at the aliquot of the separation matter is constituted. The wall of the two passage sections for preparative isolation is a borosilicate glass front face, and the sign of F-potential serves as negative from a surface electric charge condition. Since the wall of two passage by which surface treatment was carried out is covered in the nonionic finishing agent, a surface electric charge becomes weak, and the absolute value of F-potential becomes small compared with a surface non-processed passage wall. Two passage by which surface treatment was carried out is processed by the same finishing agent, and the F-potential of ** in passage is equal.

[0024] Here, the speed of the electroendosmose style at the time of impressing an electrical potential difference from the aforementioned (1) formula is so quick that the absolute value of F-potential is large. That is, the two passage sections for preparative isolation will be quick, and the electroendosmose style of the electrophoresis component of this invention will have the two late separation column sections. Separation efficiency

is bad, while there will be little analysis time amount and it will be good, if an electroendosmose style is quick. If an electroendosmose style is stopped by surface treatment, although analysis time amount will become long, **** effectiveness improves. ** which is located in an inlet side and by which surface treatment was carried out Since the separation matter for the purpose of preparative isolation can be isolated preparatively in the 1st passage section for preparative isolation at the time when the target separation arises in the passage of 1, from separation to an aliquot becomes quick. Moreover, when the passage which is located in an inlet side and by which surface treatment was carried out is inadequate in separation, it is made to dissociate further in the 2nd passage, and the separation matter for the purpose of preparative isolation can be isolated preparatively from the 2nd passage section for preparative isolation in it. Thus, in the separation process of a sample, the electrophoresis component of this invention becomes possible [isolating preparatively according to separation], and can advance separation and an aliquot efficiently. That is, the electrophoresis component of this invention can offer the fluid passage for instrumental analyses in which high separation and efficient-izing are possible by preparing the large passage section for preparative isolation of the absolute value of F-potential in a migration end between the two separation column sections with the small absolute value of F-potential. Moreover, since it is possible to apply and create a semi-conductor process technique, the fluid passage for instrumental analyses which can miniaturize detailed passage can be offered.

[0025] In an electrophoresis component according to claim 3, the value of a part of [at least] F-potential of this separation column section inside and the value of this invention of the F-potential of this passage section inside for preparative isolation are 0 or the same sign again. As a configuration it is made smaller [a configuration] than the absolute value of the F-potential of this passage section inside for preparative isolation, the absolute value of a part of [at least] F-potential of this separation column section inside can carry out suitably (the 3rd modification), and can acquire similarly the same operation effectiveness as the case where it is based on above-mentioned claim 3. In this case, the value of the F-potential of the passage wall in which surface treatment was carried out to "the value of a part of [at least] F-potential of a separation column section inside" by trimethylchlorosilane with the gestalt of the 3rd operation corresponds. With "the value of the F-potential of the passage section inside for preparative isolation", the value of the F-potential of a borosilicate glass substrate corresponds with the gestalt of the 3rd operation.

[0026] Moreover, in the electrophoresis component of claim 3 (or the 3rd modification) publication, the electrophoresis component characterized by preparing the passage section for electrical-potential-difference impression in the passage section side for impregnation of the separation column section inserted into two or more passage sections for preparative isolation is offered by this invention (claim 4).

[0027] Two, the 1st style **** for preparative isolation which crosses the center of **** of the separation column section here with the gestalt (deformation of the gestalt of the 4th operation and modification are included) of the 4th operation of the after-mentioned with "two or more passage sections for preparative isolation" in claim 4, and the 2nd passage section for preparative isolation constituted at the support liquid exhaust port side used as the migration end of the separation matter, correspond. With "the separation column section inserted into two or more passage sections for preparative

isolation" in claim 4, the 2nd separation column section located between the 1st passage section for preparative isolation and the 2nd passage section for preparative isolation corresponds with the gestalt of this 4th operation. With "the passage section for electrical-potential-difference impression" in claim 4, the branching passage of passage opening HE for electrical-potential-difference impression constituted between the 1st passage section for preparative isolation and the 2nd separation column section corresponds with the gestalt of this 4th operation.

[0028] In the case of claim 4, in addition to an operation and effectiveness of an electrophoresis component according to claim 1 to 3, the electrophoresis component of this invention has the following operation and effectiveness. The electrophoresis component of this invention has the 1st passage and 2nd passage which are committed as a separation column and by which surface treatment was carried out. Passage opening for electrical-potential-difference impression used in order to switch the 1st passage section for preparative isolation and electrical-potential-difference impression point which are used for the aliquot of the separation matter between two passage is constituted, and the 2nd passage section for preparative isolation used for the support liquid exhaust port side which serves as a migration end of the separation matter further at the aliquot of the separation matter is constituted. The 1st passage and the 2nd passage differ in the F-potential of a passage wall from the two passage sections for preparative isolation. The wall of the two passage sections for preparative isolation is a borosilicate glass front face, and the sign of F-potential serves as negative from a surface electric charge condition. Since the wall of the 1st passage by which surface treatment was carried out, and the 2nd passage is covered in the nonionic finishing agent, a surface electric charge becomes weak, and the absolute value of F-potential becomes small compared with the surface non-processed passage section wall for preparative isolation. Moreover, since it is covered by different finishing agent, the F-potential of a passage wall differs from the 1st passage by which surface treatment was carried out, and the 2nd passage. Since the 2nd passage is covered by the hydrophobic, strong finishing agent rather than the 1st passage, a surface charge becomes weak and the absolute value of F-potential becomes still smaller compared with the 1st passage.

[0029] Here, the speed of the electroendosmose style at the time of impressing an electrical potential difference from the aforementioned (1) formula is so quick that the absolute value of F-potential is large. That is, the electroendosmose style of the electrophoresis component of this invention is ** to which the 2nd passage by which surface treatment was carried out was the latest, and surface treatment was carried out. It becomes quick in order of the passage of 1, and the two passage sections for preparative isolation. Separation efficiency is bad, while there will be little analysis time amount and it will end, if an electroendosmose style is quick. If an electroendosmose style is stopped by surface treatment, although analysis time amount will become long, separation efficiency improves. Therefore, although the 1st passage by which surface treatment was carried out is inferior in separation efficiency compared with the 2nd passage, analysis time amount is short. Since the separation matter for the purpose of preparative isolation can be isolated preparatively in the 1st passage section for preparative isolation at the time when the target separation arises in the 1st passage by which surface treatment was carried out, from separation to an aliquot becomes quick. Moreover, when the 1st passage by which surface treatment was carried out is

insufficient in separation, it is made to dissociate in the 2nd passage where separation efficiency is still higher and by which surface treatment was carried out, and the separation matter for the purpose of preparative isolation can be isolated preparatively from the 2nd passage section for preparative isolation in it. Moreover, the electroendosmose style reflecting the effectiveness of surface treatment is realizable by switching and carrying out the electrical-potential-difference seal of approval of the electrical-potential-difference impression point to the 1st passage and 2nd passage by which surface treatment was carried out. That is, the electrophoresis component of this invention can offer the fluid passage for instrumental analyses in which high separation and efficient-izing are possible, as explained above. Moreover, since the electrophoresis component of this invention can apply and create a semi-conductor process technique, the fluid passage for instrumental analyses which can miniaturize detailed passage can be offered.

[0030] Bordering on this passage section for preparative isolation constituted by the location of the arbitration of this separation column section in the electrophoresis component according to claim 4 , this invention can be constituted so that the values of the F-potential of this separation column section inside may differ , it can be carried out suitably (the four to 1st modifications) , and can acquire similarly the same operation effectiveness as the case where it be based on above-mentioned claim 4 again . In this case, with "this passage section for preparative isolation constituted by the location of the arbitration of the separation column section", although the passage section for preparative isolation of the separation column section which crosses a center mostly corresponds with the gestalt of the 4th operation, the crossing location is not limited but can constitute the location of the separation column section in the location of arbitration. The value of the F-potential of the passage wall in which surface preparation was carried out by the passage wall in which surface preparation was carried out to "the value of the F-potential of a separation column section inside" by trimethylchlorosilane with the gestalt of the 4th operation, and dimethyl AROBIRU chlorosilicane corresponds. It sets for the electrophoresis component of the above-mentioned (the four to 1st modifications) publication further again. The value of the F-potential of a different separation column section inside bordering on this passage section for preparative isolation is 0 or the same sign. As a configuration it is made larger [the absolute value of the F-potential of the separation column section inside located in this passage section side for impregnation / this passage section side for impregnation / a configuration] than the absolute value of the F-potential of the separation column section inside located in the opposite side This invention can be carried out suitably (the four to 2nd modifications), and the same operation effectiveness as the case where it is based on above-mentioned claim 4 can be acquired similarly. In this case, with the gestalt of the 4th operation, the passage surface treatment was carried out [passage] by trimethylchlorosilane corresponds with "the separation column section located in the passage section side for impregnation." With "the separation column section located in the opposite side with the passage section side for impregnation", the passage surface treatment was carried out [passage] by dimethyl propyl chlorosilicane corresponds with the gestalt of the 4th operation.

[0031] Moreover, according to this invention, the plate which carried out recessing is set for the electrophoresis component which constituted two or more liquid flow channels in

piles. The passage section for impregnation which injects into this separation component the sample separated with this electrophoresis component at least, It is the electrophoresis component of which the separation column section which separates this sample crosses and consists. It has the front face of F-potential where this a part of separation column section inside [at least] differs from the F-potential of the substrate passage inside which carried out recessing. The electrophoresis component to which the front face of different F-potential from the F-potential of the substrate which carried out recessing is characterized by being constituted with the insulating inorganic material is offered (claim 5).

[0032] Although, as for "the plate which carried out recessing" in claim 5, a borosilicate glass substrate corresponds here, for example with the gestalt (deformation of the gestalt of the 5th operation and the example of modification are included) of the 5th operation of the after-mentioned, a glass substrate, a silicon wafer, a plastic plate of other materials, etc. are included. Although the slot which constitutes "the plate which carried out recessing" in claim 5 was formed by wet etching with the gestalt of this 5th operation, it can also form dry etching, machining, etc. by other technique. Moreover, it is not necessary to limit the configuration of the slot of the gestalt of the 5th operation to this configuration, and they may be other configurations. Moreover, although the slot was constituted from the 5th operation gestalt only in one substrate, it is also possible to constitute a slot also like the substrate side of another side. It is also possible for the number of the substrates which constitute a slot not to be limited, but to constitute a slot in piles two or more sheets. When the depth of flute or width of face impresses an electrical potential difference, it is desirable the range which an electroendosmose style generates, and that it is specifically 150 micrometers or less. The passage to which "the passage section for impregnation which injects the sample to separate into this separation component" in claim 5 connects a sample exhaust port with the gestalt of the 5th operation from a sample inlet corresponds. The passage to which "the separation column section which separates this sample" in claim 5 connects a support liquid exhaust port with the gestalt of the 5th operation from a support liquid inlet corresponds. With the gestalt of this 5th operation, as for "the F-potential of the substrate passage inside which carried out recessing" in claim 5, the F-potential of a borosilicate glass substrate front face corresponds, for example. Although the passage wall by which the coat was carried out with silicon-dioxide glass corresponds with the gestalt of this 5th operation, if "the insulating inorganic material" in claim 5 is an insulating inorganic material, it can be changed into other inorganic coat ingredients. For example, it can change into other glass ingredients, silicon nitride, an alumina, a diamond, tantalum pentoxide, etc. Moreover, although the SUPAKKU ring performed the coat of silicon-dioxide glass, other membrane formation approaches, for example, the chemical VUEPADEPOJISSHON method, a vacuum deposition method, etc., can also be used.

[0033] If it is in the case of claim 5, an operation of the electrophoresis component according to this invention and effectiveness can be explained as follows. The F-potential of the passage wall of the passage section for impregnation from which the electrophoresis component of this invention serves as sample induction, and the passage which is committed as a separation column and by which the surface coat was carried out differs. The wall of the passage section for impregnation is a borosilicate glass front face, and the sign of F-potential serves as negative from a surface electric charge

condition. On the other hand, since the wall of the passage by which the surface coat was carried out which works as a separation column is covered with silicon-dioxide glass, the absolute value of F-potential becomes small compared with a borosilicate glass front face.

[0034] By the way, the speed of the electroendosmose style at the time of impressing an electrical potential difference from the aforementioned (1) formula is so quick that the absolute value of F-potential is large. That is, the passage section for impregnation of a reagent will be quick, and the electroendosmose style of the electrophoresis component of this invention will have the late separation column section. Separation efficiency is bad, while there will be little analysis time amount and it will end, if an electroendosmose style is quick. If an electroendosmose style is stopped by surface treatment, although analysis time amount will become long, separation efficiency improves. Therefore, since the passage section for impregnation has the quick electroendosmose style, before being able to manage reagent installation in a short time and putting the electrophoresis component of this invention into a column, it prevents separation of a reagent, and it becomes possible [that only the separation column section makes an electroendosmose style late, and gathers separation efficiency]. That is, the electrophoresis component of this invention can offer the fluid passage for instrumental analyses in which high separation and efficient-izing are possible by making small the absolute value of the F-potential of only the separation column section. Moreover, since the passage wall by which the surface coat was carried out is an inorganic coat, even if the electrophoresis component of this invention has high endurance and performs washing by alkali etc., it does not deteriorate like organic coating. for this reason, endurance is high -- it becomes an usable electrophoresis component repeatedly. Moreover, since the electrophoresis component of this invention can apply and create a semi-conductor process technique, the fluid passage for instrumental analyses which can miniaturize detailed passage can be offered.

[0035] As a configuration which this insulating inorganic material becomes from glass ingredients, such as silica glass and HOUKEI acid glass, or silicon nitride, tantalum pentoxide, an alumina, and a diamond in an electrophoresis component according to claim 5, this invention can be carried out suitably (the 5th modification) and can acquire similarly the same operation effectiveness as the case where it is based on above-mentioned claim 5 again.

[0036]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on a drawing. Drawing 1 - drawing 3 show the gestalt of operation of the 1st of the electrophoresis component of this invention. Drawing where the perspective view of an electrophoresis component [in / in drawing 1 / the gestalt of this 1st operation] and drawing 2 looked at the substrate in the electrophoresis component of this 1st operation gestalt which carried out recessing from the recessing side, and drawing 3 are drawings with which explanation of an example of the production approach of the electrophoresis component of this 1st operation gestalt is presented.

[0037] [1st configuration of the gestalt of operation] One shows an electrophoresis component among a Fig., and this electrophoresis component 1 joins the borosilicate glass substrate 3 which carried out recessing to the borosilicate glass substrate 2, and is constituted. Passage 4 is formed of the space surrounded by the substrate 2 and the

substrate 3 which has a slot (the inside of drawing 3 , reference mark 14). Passage 4 is passage which has six branch separations, and constitutes the support liquid inlet 5, the support liquid exhaust port 6, the sample inlet 7, the sample exhaust port 8, and two reagent inlets 9 for surface treatment here.

[0038] The connector (refer to (g) and (h) in drawing 3) with a tube is formed in each opening, and the electrode 10 which consists of tubing-like platinum is connected to four places, the support liquid inlet 5, the support liquid exhaust port 6, the sample inlet 7, and the sample exhaust port 8, here. Moreover, the separation column section which connects the support liquid exhaust port 6 crosses by the intersection 11 from the passage section for impregnation which connects the sample exhaust port 8 from the sample inlet 7, and the support liquid inlet 5. Moreover, the separation column section which connects the support liquid exhaust port 6 from the support liquid inlet 5 has the configuration where it moved in a zigzag direction between the intersection 11 and the support liquid exhaust port 6. Two reagent inlets 9 for surface treatment are constituted by the intersection 11 and the tee between the support liquid exhaust ports 6.

[0039] Drawing 2 is drawing which looked at the above-mentioned substrate 3 which carried out recessing from the recessing side, and two reagent inlets 9 for surface treatment of passage 4 consist of the inlet which attached reference marks 9a and 9b. The passage between Inlets 9a-9b has the passage 12 as for which surface treatment was carried out by trimethylchlorosilane. The part of this passage 12 mainly works as a separation column.

[0040] It explains making the production approach of the electrophoresis component 1 here, and making drawing 3 reference. First, as shown in drawing 3 (a), the monotonous borosilicate glass substrate 3 which carried out optical polish is prepared. Next, as shown in drawing 3 (b), the spin coat of the photoresist is carried out to the front face of the borosilicate glass substrate 3, and the resist thin films 13 and 13 are formed. Next, as shown in drawing 3 (c), patterning of the resist thin film 13 is carried out with a photolithography technique. Next, as shown in drawing 3 (d), a substrate is dipped at the solution which mixed fluoric acid and ammonium fluoride, and wet etching of the borosilicate glass substrate 3 is carried out by using as a mask the resist thin film 13 which carried out patterning, and it considers as the borosilicate glass substrate 3 which has a slot 14. As for a slot 14, it is desirable for the depth of flute to be 150 micrometers or less. Next, as shown in drawing 3 (e), the resist thin film 13 used as an etching mask using the plasma asher is removed. Next, as shown in drawing 3 (f), it opens a hole (2a) with the borosilicate glass substrate 3 which carried out recessing, the borosilicate glass substrate [finishing / processing] 2 is piled up, and it heats at a heater 15, and joins by the heat joining method. Whenever [stoving temperature] has desirable 500-800 degrees C. Next, as shown in drawing 3 (g), a connector 16 is joined with adhesives. Next, as shown in drawing 3 (h), the electrode 10 which consists of tubing-like platinum through a tube 17 was connected, and the electrophoresis component 1 was completed.

[0041] Next, the surface treatment approach is explained. The support liquid inlet 5, the support liquid exhaust port 6, the sample inlet 7, and the sample exhaust port 8 of the electrophoresis component 1 are sealed altogether. Next, a peri star pump is connected to reagent inlet 9b for surface treatment, and the dichloromethane solution of trimethylchlorosilane is made to pour in 10% from reagent inlet 9for surface treatment a by suction. surface treatment was carried out by leaving it for about 10 minutes after

impregnation -- it obtained passage 12.
[0042] Next, the separation experiment using the electrophoresis component 1 is explained. First, a high voltage power supply is connected to four electrodes 10. An anode plate is connected to the electrode 10 of the support liquid inlet 5 and the sample inlet 7, and cathode is connected to the electrode 10 of the support liquid exhaust port 6 and the sample exhaust port 8. The migration buffer is beforehand filled to the whole in passage 4. Next, the sample for separating into the sample inlet 7 is poured in. An electrical potential difference is impressed between the sample inlet 7 and the sample exhaust port 8, and a sample is introduced toward the sample exhaust port 8 from the sample inlet 7 by the electroendosmose style. Next, an electrical potential difference is impressed between the support liquid inlet 5 and the support liquid exhaust port 6, and the sample which exists in an intersection 11 is made to migrate toward the support liquid exhaust port 6 by the electroendosmose style. A migration sample migrates toward the support liquid exhaust port 6, dissociating through the passage which has the passage 12 by which surface treatment was carried out on the way.
[0043] [An operation and effectiveness] of the gestalt of the 1st operation Next, an operation and effectiveness of the gestalt of this 1st operation are explained. Although analyzed by filling an electrolytic solution as support liquid to a capillary tube in capillary electrophoresis, an electric double layer is formed between the electrolytic solutions which touch a capillary tube wall and this by this. If an electrical potential difference is impressed here, an electrolytic solution will move with a solvent and an electroendosmose style will arise. An electric **** style can be used as driving force to which the separated component ion is moved. The electroendosmose rate of flow upsilon is expressed with the following formula as relation of electric-field-strength E applied along with the dielectric constant epsilon of an electrolytic solution, coefficient of viscosity eta, F-potential xi, and a capillary tube. F-potential is a capillary tube wall and the potential difference of electrolytic solution tubing.
[Equation 2] upsilon=-(epsilon xi/eta) E .... (1)
[0044] F-potential xi -- the electric charge condition of a capillary tube wall -- setting -- positive/negative -- although any sign can be taken -- usually -- business -- on the glass front face used for a capillary tube, since it becomes negative, upsilon becomes forward, therefore an electroendosmose style goes to cathode from an anode plate.
[0045] The separation column section which connects the support liquid exhaust port 6 has the front face of F-potential where a part of separation column section inside [at least] differs from the F-potential of the passage section inside for impregnation while crossing by the intersection 11 from the passage section for impregnation and the support liquid inlet 5 to which the electrophoresis component 1 according to the gestalt of this operation here connects the sample exhaust port 8 from the sample inlet 7.
[0046] That is, the F-potential of the passage wall of the passage section for impregnation which connects the sample exhaust port 8, and the passage 12 which is committed as a separation column and by which surface treatment was carried out differs from the sample inlet 7 where the above-mentioned electrophoresis component 1 serves as sample induction. The wall of the passage to which the sample exhaust port 8 is connected from the sample inlet 7 is a borosilicate glass front face, and the sign of F-potential serves as negative from a surface electric charge condition. On the other hand, since the wall of the passage 12 by which surface treatment was carried out which

works as a separation column is covered in the nonionic finishing agent, a surface electric charge becomes weak, and the absolute value of F-potential becomes small compared with a surface non-processed passage wall.

[0047] (1) The speed of the electroendosmose style at the time of impressing an electrical potential difference from a formula is so quick that the absolute value of F-potential is large. That is, the passage section for impregnation of a reagent will be quick, and the electroendosmose style of the above-mentioned electrophoresis component 1 will have the late separation column section. Separation efficiency is bad, while there will be little analysis time amount and it will end, if an electroendosmose style is quick. If an electroendosmose style is stopped by surface treatment, although analysis time amount will become long, separation efficiency improves. Therefore, since the passage section for impregnation has the quick electroendosmose style, before being able to manage reagent installation in a short time and putting the above-mentioned electrophoresis component 1 into a column, it prevents separation of a reagent, and it becomes possible [that only the separation column section makes an electroendosmose style late, and gathers separation efficiency]. That is, the electrophoresis component 1 can offer the fluid passage for instrumental analyses in which high separation and efficient-izing are possible by making small the absolute value of the F-potential of only the separation column section. Moreover, since the electrophoresis component 1 can apply and create a semi-conductor process technique as indicated to the above-mentioned creation approach (drawing 3), the fluid passage for instrumental analyses which can miniaturize detailed passage can be offered. In this way, if the configuration of the gestalt of this operation is followed, the electrophoresis component for instrumental analyses which can be miniaturized will be realized possible [high separation and efficient-izing].

[0048] [Deformation of the gestalt of the 1st operation and modification] In addition, naturally, various deformation and modification are possible for each configuration of the gestalt of this 1st operation.

[1-1] For example, the glass substrate of other materials and modification of silicon WEHAHE are possible for the borosilicate glass substrate 2 and the borosilicate glass substrate 3. Moreover, modification to a plastic plate is also possible.

[1-2] The passage 4 constituted by the space surrounded by the substrate 2 and the substrate 3 which has a slot is possible also for changing into the configuration which has substrate 2 fang furrow, and can also be made the configuration in which substrates 2 and 3 have a slot.

[0049] [1-3] If it is two or more pieces, it will not be limited to the number, but two or more reagent inlets for surface treatment are constituted, and two reagent inlets 9 for surface treatment can also carry out surface treatment partial at two or more finishing agents.

[1-4] Moreover, although the separation column section which connects the support liquid exhaust port 6 from the support liquid inlet 5 has the configuration where it moved in a zigzag direction between the intersection 11 and the support liquid exhaust port 6, a configuration is not limited but modification to a straight-line configuration etc. is possible for it.

[1-5] The material of the electrode 10 which consists of platinum is not limited to platinum, but can be changed into other conductive matter, such as gold. Moreover, it is

not limited to four places, the support liquid inlet 5, the support liquid exhaust port 6, the sample inlet 7, and the sample exhaust port 8, but it connects with two reagent inlets 9 for surface treatment, and the part where the electrode is connected can also carry out adjustable [of the electrical-potential-difference impression point].
[0050] [1-6] Moreover, it is also possible for especially the positive/negative of the connected electrode not to be limited but to carry out adjustable according to the purpose. For example, since an electroendosmose style flows to a positive electrode when the sign of the value of F-potential is a forward front face, the same migration of the positive/negative of the electrode to connect becomes possible by carrying out to this operation gestalt reversely.
[1-7] The trimethylchlorosilane used for surface preparation can be changed into other general finishing agents. For example, it can change into other silane coupling agents. Moreover, it can also change into hydrophilic macromolecules, surfactants, etc., such as a carboxymethyl cellulose and polyacrylamide. Also in the deformation in the following examples, and modification, these points apply.
[0051] [2nd configuration of the gestalt of operation] Next, the gestalt of operation of the 2nd of the electrophoresis component of this invention is shown. This operation gestalt is an electrophoresis component of which the separation column section which separates a sample, and the passage section for preparative isolation which isolates the separated sample preparatively cross and consist, and the F-potential of the passage inside for preparative isolation will make it have the front face of F-potential where a part of separation column section insides [at least] differ. The gestalt of this operation can also catch the modification of the gestalt of said 1st operation. The perspective view of the electrophoresis component [in / in drawing 4 / the gestalt of this 2nd operation] 20 and drawing 5 are drawings which looked at the substrate in that electrophoresis component 20 which carried out recessing from the recessing side.
[0052] A fundamental configuration may be the same with having illustrated with the 1st operation gestalt, and this electrophoresis component 20 joins the borosilicate glass substrate 22 which carried out recessing to the borosilicate glass substrate 21, and is constituted. Passage 23 is formed of the space surrounded by the substrate 21 and the substrate 22 which has a slot.
[0053] Passage 23 is passage which has eight branch separations, and constitutes the support liquid inlet 5, the support liquid exhaust port 6, the sample inlet 7, the sample preparative isolation opening 24 (24a, 24b) of 8 or 2 sample exhaust ports, and two reagent inlets 9 for surface treatment here. The connector with a tube is formed in each opening, and the electrode 10 which consists of tubing-like platinum is connected to the support liquid inlet 5, the support liquid exhaust port 6, the sample inlet 7, the sample exhaust port 8, and the sample preparative isolation opening 24. Moreover, the separation column section which connects the support liquid exhaust port 6 crosses by the intersection 11 from the passage section for impregnation which connects the sample exhaust port 8 from the sample inlet 7, and the support liquid inlet 5. Moreover, the passage section for preparative isolation which connects preparative isolation opening 24a to preparative isolation opening 24b to the separation column section which connects the support liquid exhaust port 6 from the support liquid inlet 5 crosses by the intersection 25. Moreover, the separation column section which connects the support liquid exhaust port 6 from the support liquid inlet 5 has the configuration where it moved

in a zigzag direction between the intersection 11 and the intersection 25. Two reagent inlets 9 for surface treatment are constituted by the tee between an intersection 11 and an intersection 25.

[0054] Drawing 5 is drawing which looked at the above-mentioned substrate 22 which carried out recessing from the recessing side, and two reagent inlets 9 for surface treatment of passage 23 consist of Inlets 9a and 9b. The passage between Inlets 9a-9b has the passage wall 12 in which surface treatment was carried out by trimethylchlorosilane. The part of ** 12 in this passage mainly works as a separation column.

[0055] The production approach of this electrophoresis component 20 is the same as the production approach (drawing 3) of the electrophoresis component 1 shown in the 1st operation gestalt, and produces by designing the mask pattern used for a photograph RISOGURA fee for the electrophoresis components 20.

[0056] The surface treatment approach is the same as the surface treatment approach of the electrophoresis component 1 shown in the 1st operation gestalt. That is, the support liquid inlet 5 of the electrophoresis component 20, the support liquid exhaust port 6, the sample inlet 7, the sample exhaust port 8, and two sample preparative isolation openings 24 are sealed altogether. Next, a peri star pump is connected to reagent inlet 9b for surface treatment, and the dichloromethane solution of trimethylchlorosilane is made to pour in 10% from reagent inlet 9for surface treatment a by suction. By leaving it for about 10 minutes after impregnation, the passage 12 by which surface treatment was carried out was obtained.

[0057] Next, separation / preparative isolation experiment using this electrophoresis component 20 is explained. First, a high voltage power supply is connected to six electrodes 10. An anode plate is connected to the electrode of the support liquid inlet 5, the sample inlet 7, and preparative isolation opening 24a, and cathode is connected to the electrode of the support liquid exhaust port 6, the sample exhaust port 8, and preparative isolation opening 24b. The migration buffer is beforehand filled to the whole in passage 23. Next, the sample for separating into the sample inlet 7 is poured in. An electrical potential difference is impressed between the sample inlet 7 and the sample exhaust port 8, and a sample is introduced toward the sample exhaust port 8 from the sample inlet 7 by the electroendosmose style. Next, an electrical potential difference is impressed between the support liquid inlet 5 and the support liquid exhaust port 6, and the sample which exists in an intersection 11 is made to migrate toward the support liquid exhaust port 6 by the electroendosmose style. A migration sample migrates toward the support liquid exhaust port 6, dissociating through the passage which has the passage 12 by which surface treatment was carried out on the way.

[0058] Here, a separation condition is detected using the detection system of the separation matter which is not illustrated in the support liquid inlet 5 side of an intersection 25 or an intersection 25. In case the separation matter for the purpose of preparative isolation passes an intersection 25, impress an electrical potential difference between preparative isolation opening 24a and preparative isolation opening 24b, only this separation matter is made to migrate toward preparative isolation opening 24b, and it isolates preparatively.

[0059] [An operation and effectiveness] of the gestalt of the 2nd operation Next, an operation and effectiveness of the gestalt of this 2nd operation are explained. The

electrophoresis component 20 according to the gestalt of this operation has the following operation and effectiveness while doing so the same operation and effectiveness as the 1st operation gestalt.

[0060] The F-potential of a passage wall with the passage section for preparative isolation which connects preparative isolation opening 24a to preparative isolation opening 24b used for the aliquot of the separation matter to the passage 12 which the above-mentioned electrophoresis component 20 commits as a separation column, and by which surface treatment was carried out differs. The wall of the passage to which preparative isolation opening 24a to preparative isolation opening 24b is connected is a borosilicate glass front face, and the sign of F-potential serves as negative from a surface electric charge condition. On the other hand, since the wall of the passage 12 by which surface treatment was carried out which works as a separation column is covered in the nonionic finishing agent, a surface electric charge becomes weak, and the absolute value of F-potential becomes small compared with a surface non-processed passage wall.

[0061] Here, the speed of the electroendosmose style at the time of impressing an electrical potential difference from (1) type given in the 1st operation gestalt is so quick that the absolute value of F-potential is large. That is, the passage section for preparative isolation will be quick, and the electroendosmose style of the above-mentioned electrophoresis component 20 will have the late separation column section. Separation efficiency is bad, while there will be little analysis time amount and it will end, if an electroendosmose style is quick. If an electroendosmose style is stopped by surface treatment, although analysis time amount will become long, separation efficiency improves. Therefore, the above-mentioned electrophoresis component 20 becomes possible [only the separation column section making an electroendosmose style late, and gathering separation efficiency, being able to perform an aliquot in a short time, since the passage section for preparative isolation has the quick electroendosmose style, and preventing separation of a reagent before preparative isolation].

[0062] That is, the electrophoresis component 20 can offer the fluid passage for instrumental analyses in which high separation and efficient-izing are possible by making small the absolute value of the F-potential of only the separation column section. Moreover, since the electrophoresis component 20 can apply and create a semi-conductor process technique like the case of the 1st operation gestalt as indicated to the above-mentioned creation approach, the fluid passage for instrumental analyses which can miniaturize detailed passage can be offered. This invention can be carried out in this way, and can also be carried out.

[0063] [Deformation of the gestalt of the 2nd operation and modification] In addition, naturally, various deformation and modification ([deformation of the gestalt of the 1st operation and modification] are included) are possible also for each configuration of the gestalt of this 2nd operation like the 1st operation gestalt.

[0064] [2-1] The electrophoresis component 30 which is an example of modification at the time of constituting four reagent inlets for surface treatment in drawing 6 especially is shown. This electrophoresis component 30 joins the borosilicate glass substrate 32 which carried out recessing to the borosilicate glass substrate 31, and is constituted. The electrophoresis component 30 has four reagent inlets 9 (9a, 9b, 9c, 9d) for surface treatment. These four reagent inlets 9 for surface treatment are constituted by the tee

between an intersection 11 and an intersection 25. Drawing 7 is a drawing which looked at the above-mentioned substrate 32 which carried out recessing from the recessing front face. Passage 33 has the passage wall 34 which poured in and discharged the finishing agent and processed it from the reagent inlets 9a and 9b for surface treatment, and the passage wall 35 which poured in and discharged the finishing agent and processed it from the reagent inlets 9c and 9d for surface treatment. Thus, various surface treatment becomes possible by forming many reagent inlets 9 for surface treatment. This invention may be carried out in this way, and may be carried out.

[0065] [3rd configuration of the gestalt of operation] Next, the gestalt of operation of the 3rd of the electrophoresis component of this invention is shown. This operation gestalt is an electrophoresis component which has two or more passage sections for preparative isolation, and at least one passage section for preparative isolation is constituted by the location of the arbitration of the separation column section, and it will make it a part of [at least] ZE evening potentials of the separation column section inside of both ends have the front face of F-potential where the ZE evening potentials of this passage inside for preparative isolation differ bordering on this passage section for preparative isolation. The gestalt of this operation can also be caught with the modification of the gestalt of said 1st operation, and can also be caught with the modification of the gestalt (the example of deformation of the gestalt of the 2nd operation and modification is included) of said 2nd operation. The perspective view of the electrophoresis component [in / in drawing 8 / the gestalt of this 3rd operation] 40 and drawing 9 are drawings which looked at the substrate in that electrophoresis component 40 which carried out recessing from the recessing side.

[0066] A fundamental configuration may be the same with having illustrated with the 1st and 2nd operation gestalt, and this electrophoresis component 40 joins the borosilicate glass substrate 42 which carried out recessing to the borosilicate glass substrate 41, and is constituted. Passage 43 is formed of the space surrounded by the substrate 41 and the substrate 42 which has a slot.

[0067] Passage 43 is passage which has 12 branch separations, and constitutes one pair of sample preparative isolation openings 24 (24a, 24b) and 44 (44a, 44b), and four reagent inlets 9 for surface treatment from the support liquid inlet 5, a support liquid exhaust port 6, a sample inlet 7, and 8 or 2 sample exhaust ports here. The connector with a tube is formed in each opening, and they are the support liquid inlet 5, the support liquid exhaust port 6, the sample inlet 7, and a sample exhaust port. The electrode 10 which consists of tubing-like platinum is connected to 8 and the sample preparative isolation opening 24 ****** preparative isolation opening 44.

[0068] Moreover, sample inlet The separation column section which connects the support liquid exhaust port 6 crosses by the intersection 11 from the passage section for impregnation which connects the sample exhaust port 8 from 7, and the support liquid inlet 5. Moreover, the passage section for preparative isolation which connects preparative isolation opening 24a to preparative isolation opening 24b to the separation column section which connects the support **** outlet 6 from the support liquid inlet 5 crosses by the intersection 25. Moreover, the passage section for preparative isolation which connects preparative isolation opening 44a to preparative isolation opening 44b to the separation column section which connects the support liquid exhaust port 6 from the support liquid inlet 5 crosses by the intersection 45 located in the center of the

separation column section. Moreover, the separation column section which connects the support liquid exhaust port 6 from the support liquid inlet 5 has the configuration where it moved in a zigzag direction between an intersection 11 and an intersection 45 and between the intersection 45 and the intersection 25. Four reagent inlets 9 for surface treatment are constituted between [two] two pieces, the intersection 45, and the intersection 25 by the tee between an intersection 11 and an intersection 45.

[0069] Drawing 9 is drawing which looked at the above-mentioned substrate 42 which carried out recessing from the recessing side. Four reagent inlets 9 for surface treatment of passage 43 consist of each Inlets [9a-9d] inlet. It has the passage wall 47 with which surface preparation of the passage between Inlets 9c-9d was carried out by trimethylchlorosilane in the passage wall 46 with which surface preparation of the passage between Inlets 9a-9b was carried out by trimethylchlorosilane. The part of ** 46 and 47 in this passage mainly works as a separation column.

[0070] The production approach of this electrophoresis component 40 is the same as the production approach (drawing 3) of the electrophoresis component 1 shown in the 1st operation gestalt, and produces by designing the mask pattern used for a photograph RISOGURA fee for the electrophoresis components 40.

[0071] The surface treatment approach is the same as the surface treatment approach of the electrophoresis component 1 shown in the 1st operation gestalt. That is, all of the entrance of liquid other than reagent inlet 9a for surface treatment and 9b are sealed first. Next, a peri star pump is connected to reagent inlet 9b for surface treatment, and the dichloromethane solution of trimethylchlorosilane is made to pour in 10% from reagent inlet 9for surface treatment a by suction. By leaving it for about 10 minutes after impregnation, the passage 46 by which surface treatment was carried out was obtained. Next, all of the entrance of liquid other than reagent inlet 9c for surface treatment and 9d are sealed. Next, a peri star pump is connected to 9d of reagent ****** for surface treatment, and the dichloromethane solution of trimethylchlorosilane is made to pour in 10% from reagent inlet 9for surface treatment c by suction. By leaving it for about 10 minutes after impregnation, the passage 47 by which surface treatment was carried out was obtained.

[0072] Next, separation / preparative isolation experiment using this electrophoresis component 40 is explained. First, a high voltage power supply is connected to eight electrodes 10. An anode plate is connected to the electrode of the support liquid inlet 5, the sample inlet 7, preparative isolation opening 24a, and preparative isolation opening 44a, and cathode is connected to the electrode of the support liquid exhaust port 6, the sample exhaust port 8, preparative isolation opening 24b, and preparative isolation opening 44b. The migration buffer is beforehand filled to the whole in passage 43.

[0073] Next, the sample for separating into the sample inlet 7 is poured in. An electrical potential difference is impressed between the sample inlet 7 and the sample exhaust port 8, and a sample is introduced toward the sample exhaust port 8 from the sample inlet 7 by the electroendosmose style. Next, an electrical potential difference is impressed between the support liquid inlet 5 and the support liquid exhaust port 6, and the sample which exists in an intersection 11 is made to migrate toward the support liquid exhaust port 6 by the electroendosmose style. A migration sample migrates toward the support liquid exhaust port 6, dissociating through the passage which has the passage 46 by which surface treatment was carried out on the way.

[0074] Here, a separation condition is detected using the detection system of the separation matter which is not illustrated in the support liquid inlet 5 side of an intersection 45 or an intersection 45. When the target separation has arisen at this detecting point, in case the separation matter for the purpose of preparative isolation passes an intersection 45, impress an electrical potential difference between preparative isolation opening 44a and preparative isolation opening 44b, only this separation matter is made to migrate toward preparative isolation opening 24b, and it isolates preparatively. When the detecting point of an intersection 45 of the separation made into the purpose is inadequate, electrical-potential-difference impression of a between [the support liquid inlet 5 and the support liquid exhaust port 6] is continued. A migration sample migrates toward the support liquid exhaust port 6, dissociating through the passage which has the passage 47 by which surface treatment was carried out on the way.
[0075] Furthermore, a separation condition is detected using the detection system of the separation matter which is not illustrated in the support liquid inlet 5 side of an intersection 25 or an intersection 25. In case the separation matter for the purpose of preparative isolation passes an intersection 25, impress an electrical potential difference between preparative isolation opening 24a and preparative isolation opening 24b, only this separation matter is made to migrate toward preparative isolation opening 24b, and it isolates preparatively.
[0076] [An operation and effectiveness] of the gestalt of the 3rd operation Next, an operation and effectiveness of the gestalt of this 3rd operation are explained. The electrophoresis component 40 according to the gestalt of this operation has the following operation and effectiveness while doing so the same operation and effectiveness as the 1st and 2nd operation gestalt.
[0077] The above-mentioned electrophoresis component 40 has two passage 46 and 47 which is committed as a separation column and by which surface treatment was carried out. The passage section for preparative isolation which connects preparative isolation opening 44a to preparative isolation opening 44b used for the aliquot of the separation matter between passage 46 and 47 is constituted, and the passage section for preparative isolation which connects preparative isolation opening 24a to preparative isolation opening 24b used for the aliquot of the separation matter to the support liquid exhaust port 6 side which serves as a migration end of the separation matter further is constituted. The wall of the two passage sections for preparative isolation is a borosilicate glass front face, and the sign of F-potential serves as negative from a surface electric charge condition. Since inner ** of the passage 46 and 47 by which surface treatment was carried out is covered in the nonionic finishing agent, a surface electric charge becomes weak, and the absolute value of F-potential becomes small compared with non-processed surface ** in passage. Passage 46 and passage 47 are processed by the same finishing agent, and its F-potential of ** in passage is equal.
[0078] Here, the speed of the electroendosmose style at the time of impressing an electrical potential difference from (1) type given in the 1st operation gestalt is so quick that the absolute value of F-potential is large. That is, the two passage sections for preparative isolation will be quick, and the electroendosmose style of the above-mentioned electrophoresis component 40 will have the two late separation column sections. Separation efficiency is bad, while there will be little analysis time amount and it will end, if an electroendosmose style is quick. If an electroendosmose style is stopped by

surface treatment, although analysis time amount will become long, separation efficiency improves. Since the separation matter for the purpose of preparative isolation can be isolated preparatively in the passage section for preparative isolation which connects preparative isolation opening 44a to preparative isolation opening 44b at the time when the target separation arises in passage 46, from separation to an aliquot becomes quick. Moreover, when passage 46 is inadequate in separation, the separation matter for the purpose of preparative isolation can be isolated preparatively from the passage section for preparative isolation which is made to dissociate further in passage 47 and connects preparative isolation opening 24b from preparative isolation opening 24a in it. Thus, in the separation process of a sample, the electrophoresis component 40 becomes possible [isolating preparatively according to separation], and can advance separation and an aliquot efficiently.

[0079] That is, the electrophoresis component 40 can offer the fluid passage for instrumental analyses in which high separation and efficient-izing are possible by preparing the large passage section for preparative isolation of the absolute value of F-potential in the question and migration end of the two separation column sections with a small absolute value of F-potential. Moreover, since the electrophoresis component 40 can apply and create a semi-conductor process technique like the case of the 1st operation gestalt as indicated to the above-mentioned creation approach, the fluid passage for instrumental analyses which can miniaturize detailed passage can be offered. This invention can be carried out in this way, and can also be carried out.

[0080] [Deformation of the gestalt of the 3rd operation and modification] In addition, naturally, various deformation and modification ([deformation of the gestalt of the 2nd operation and modification] are included including [deformation of the gestalt of the 1st operation and modification]) are possible for each configuration of the gestalt of this 3rd operation like the 1st and 2nd operation gestalt.

[0081] [3-1] For example, although the passage section for preparative isolation which connects preparative isolation opening 44a to preparative isolation opening 44b to the separation column section which connects the support liquid exhaust port 6 from the support liquid inlet 5 crosses by the intersection 45 located in the center of the separation column section, the location of this intersection is not limited but can be constituted in the location of arbitration.

[3-2] Moreover, the number of the passage sections for preparative isolation constituted from a support liquid inlet 5 by the location of the arbitration of the separation column section which connects the support liquid exhaust port 6 is not limited, either.

[3-3] Moreover, it is also possible for the separation column section divided in this passage section for preparative isolation to perform the same surface treatment possible [making surface treatment from which each differs into F-potential which gives and is different].

[3-4] After-mentioned drawing 14 and deformation as shown in 15 are also still more possible. This invention may be carried out in this way, and may be carried out.

[0082] [4th configuration of the gestalt of operation] Next, the gestalt of operation of the 4th of the electrophoresis component of this invention is shown. this operation gestalt prepares the passage section for electrical-potential-difference impression in the passage section side for impregnation of the separation column section inserted into two or more passage sections for preparative isolation, and is ****** while it has two or

more passage sections for preparative isolation. The gestalt of this operation can also be caught with the modification of the gestalt of said 1st operation, and can also be caught with the modification of the gestalt (the example of deformation of the gestalt of the 2nd operation and modification is included) of said 2nd operation, and can also be caught with the modification of the gestalt (the example of deformation of the gestalt of the 3rd operation and modification is included) of said 3rd operation. The perspective view of the electrophoresis component [in / in drawing 10 / the gestalt of this 4th operation] 50 and drawing 11 are drawings which looked at the substrate in that electrophoresis component 50 which carried out recessing from the recessing side.

[0083] A fundamental configuration may be the same with having illustrated with the 1st, 2nd, and 3rd operation gestalt, and this electrophoresis component 50 joins the borosilicate glass substrate 52 which carried out recessing to the borosilicate glass substrate 51, and is constituted. Passage 53 is formed of the space surrounded by the substrate 51 and the substrate 52 which has a slot.

[0084] Passage 53 is passage which has 13 branch separations, and constitutes one pair of sample preparative isolation openings 24 (24a, 24b), 44 (44a, 44b) or 4 reagent inlets 9 for surface treatment, and the passage opening 54 for electrical-potential-difference impression from the support liquid inlet 5, a support liquid exhaust port 6, a sample inlet 7, and 8 or 2 sample exhaust ports here. The connector with a tube is formed in each opening, and the electrode 10 which consists of tubing-like platinum is connected to the support liquid inlet 5, the support liquid exhaust port 6, the sample inlet 7, the sample exhaust port 8, the sample preparative isolation opening 24, the sample preparative isolation opening 44, and the passage opening 54 for electrical-potential-difference impression. The passage opening 54 for electrical-potential-difference impression can be used for switching the electrical-potential-difference impression point.

[0085] Moreover, the separation column section which connects the support liquid exhaust port 6 crosses by the intersection 11 from the passage section for impregnation which connects the sample exhaust port 8 from the sample inlet 7, and the support liquid inlet 5. Moreover, the passage section for preparative isolation which connects preparative isolation opening 24a to preparative isolation opening 24b to the separation column section which connects the support liquid exhaust port 6 from the support liquid inlet 5 crosses by the intersection 25. Moreover, the passage section for preparative isolation which connects preparative isolation opening 44a to preparative isolation opening 44b to the separation column section which connects the support liquid exhaust port 6 from the support liquid inlet 5 crosses by the intersection 45 of the separation column section mostly located in the center. Moreover, the separation column section which connects the support liquid exhaust port 6 from the support liquid inlet 5 has the configuration where it moved in a zigzag direction between an intersection 11 and an intersection 45 and between the intersection 45 and the intersection 25. Four reagent inlets 9 for surface treatment are constituted between [two] two pieces, the intersection 45, and the intersection 25 by the tee between an intersection 11 and an intersection 45.

[0086] Drawing 11 is drawing which looked at the above-mentioned substrate 52 which carried out recessing from the recessing side. Four reagent inlets 9 for surface treatment of passage 53 consist of each Inlets [9a-9d] inlet. It has the passage wall 55 with which surface preparation of the passage between 9c-9d was carried out by dimethyl AROBIRU

chlorosilicane in the passage wall 46 with which surface preparation of the passage between Inlets 9a-9b was carried out by trimethylchlorosilane. The part of these passage walls 46 and 55 mainly works as a separation column. The passage opening 54 for electrical-potential-difference impression is constituted by the branching passage between an intersection 45 and the passage wall 55.

[0087] The production approach of this electrophoresis component 50 is the same as the production approach (drawing 3) of the electrophoresis component 1 shown in the 1st operation gestalt, and produces by designing the mask pattern used for a photograph RISOGURA fee for the electrophoresis components 50.

[0088] The surface treatment approach is the same as the surface treatment approach of the electrophoresis component 1 shown in the 1st operation gestalt. That is, all of the entrance of liquid other than reagent inlet 9a for surface treatment and 9b are sealed first. Next, peri star BOMPU is connected to reagent inlet 9b for surface preparation, and the dichloromethane solution of trimethylchlorosilane is made to pour in 10% from reagent inlet 9for surface preparation a by suction. By leaving it for about 10 minutes after impregnation, the passage 46 by which surface treatment was carried out was obtained. Next, all of the entrance of liquid other than reagent inlet 9c for surface treatment and 9d are sealed. Next, a peri star pump is connected to 9d of reagent inlets for surface treatment, and the dichloromethane solution of dimethyl propyl chlorosilicane is made to pour in 10% from reagent inlet 9for surface treatment c by suction. By leaving it for about 10 minutes after impregnation, the passage 55 by which surface treatment was carried out was obtained.

[0089] Next, separation / preparative isolation experiment using this electrophoresis component 50 is explained. First, a high voltage power supply is connected to nine electrodes 10. An anode plate is connected to the electrode of the support liquid inlet 5, the sample inlet 7, preparative isolation opening 24a, and preparative isolation opening 44a, and cathode is connected to the electrode of the support liquid exhaust port 6, the support liquid exhaust port 6, the sample exhaust port 8, preparative isolation opening 24b, preparative isolation opening 44b, and the passage opening 54 for electrical-potential-difference impression. The migration buffer is beforehand filled to the whole in passage 53.

[0090] Next, the sample for separating into the sample inlet 7 is poured in. An electrical potential difference is impressed between the sample inlet 7 and the sample exhaust port 8, and a sample is introduced toward the sample exhaust port 8 from the sample inlet 7 by the electroendosmose style. Next, an electrical potential difference is impressed between the support liquid inlet 5 and the passage opening 54 for electrical-potential-difference impression, and the sample which exists in an intersection 11 is made to migrate toward the passage opening 54 for electrical-potential-difference impression by the electroendosmose style. A migration sample migrates toward the passage opening 54 for electrical-potential-difference impression, dissociating through the passage which has the passage 46 by which surface treatment was carried out on the way.

[0091] Here, a separation condition is detected using the detection system of the separation matter which is not illustrated in the support liquid inlet 5 side of an intersection 45 or an intersection 45. When the target separation has arisen at this detecting point, in case the separation matter for the purpose of preparative isolation

passes an intersection 45, impress an electrical potential difference between preparative isolation opening 44a and preparative isolation opening 44b, only this separation matter is made to migrate toward preparative isolation opening 24b, and it isolates preparatively. When the detecting point of an intersection 45 of the separation made into the purpose is inadequate, immediately after a sample passes an intersection 45, an electrical potential difference is impressed between preparative isolation opening 44a and the support liquid exhaust port 6. A migration sample migrates toward the support liquid exhaust port 6, dissociating through the passage which has the passage 55 by which surface treatment was carried out on the way.

[0092] Furthermore, a separation condition is detected using the detection system of the separation matter which is not illustrated in the support liquid inlet 5 side of an intersection 25 or an intersection 25. In case the separation matter for the purpose of preparative isolation passes an intersection 25, impress an electrical potential difference between preparative isolation opening 24a and preparative isolation opening 24b, only this separation matter is made to migrate toward preparative isolation opening 24b, and it isolates preparatively.

[0093] [An operation of the gestalt of the 4th operation and effectiveness] Next, an operation and effectiveness of the gestalt of this 4th operation are explained. The electrophoresis component 50 according to this operation gestalt is the 1st, The 2nd, While doing so the same operation and effectiveness as the 3rd operation gestalt, it has the following operation and effectiveness. The above-mentioned electrophoresis component 50 has two passage 46 and 55 which is committed as a separation column and by which surface treatment was carried out. The passage opening 54 for electrical-potential-difference impression used in order to switch the passage section for preparative isolation which connects preparative isolation opening 44a to preparative isolation opening 44b used for the aliquot of the separation matter between passage 46 and 55, and the electrical-potential-difference impression point is constituted. The passage section for preparative isolation which connects preparative isolation opening 24a to preparative isolation opening 24b used for the aliquot of the separation matter to the support liquid exhaust port 6 side which furthermore serves as a migration end of the separation matter is constituted. Passage 46 and passage 55 differ in the F-potential of ** in passage from the two passage sections for preparative isolation. The wall of the two passage sections for preparative isolation is a borosilicate glass front face, and the sign of F-potential serves as negative from a surface electric charge condition. Since the wall of the passage 46 and 55 by which surface treatment was carried out is covered in the nonionic finishing agent, a surface electric charge becomes weak, and the absolute value of F-potential becomes small compared with a surface non-processed passage wall. Moreover, since it is covered by finishing agent which is different in passage 46 and passage 55 The F-potential of a passage wall differs., Since passage 55 is covered by the hydrophobic, strong finishing agent rather than passage 46 A surface charge becomes weak and the absolute value of F-potential becomes still smaller compared with passage 46.,

[0094] Here, the speed of the electroendosmose style at the time of impressing an electrical potential difference from (1) type given in the 1st operation gestalt is so quick that the absolute value of F-potential is large. That is, the electroendosmose style of the above-mentioned electrophoresis component 50 has the latest passage 55, and it

becomes quick in order of passage 46 and the two passage sections for preparative isolation. Separation efficiency is bad, while there will be little analysis time amount and it will end, if an electroendosmose style is quick. If an electroendosmose style is stopped by surface treatment, although analysis time amount will become long, separation efficiency improves. Therefore, although separation efficiency is inferior compared with passage 55, the analysis time amount of passage 46 is short. Since the separation matter for the purpose of preparative isolation can be isolated preparatively in the passage section for preparative isolation which connects preparative isolation opening 44a to preparative isolation opening 44b at the time when the target separation arises in passage 46, from separation to an aliquot becomes quick. Moreover, when passage 46 is inadequate in separation, the separation matter for the purpose of preparative isolation can be isolated preparatively from the passage section for preparative isolation which is made to dissociate in the passage 55 where separation efficiency is still higher, and connects preparative isolation opening 24b from preparative isolation opening 24a in it. Moreover, the electroendosmose style reflecting the effectiveness of surface treatment is realizable by switching and carrying out the electrical-potential-difference seal of approval of the electrical-potential-difference impression point to passage 46 and passage 55.

[0095] That is, the electrophoresis component 50 can offer the fluid passage for instrumental analyses in which high separation and efficient-izing are possible, as explained to the above-mentioned operation and effectiveness. Moreover, since the electrophoresis component 50 can apply and create a semi-conductor process technique as indicated to the above-mentioned creation approach, the fluid passage for instrumental analyses which can miniaturize detailed passage can be offered. This invention which makes the electrophoresis component for instrumental analyses which can be miniaturized realize possible [high separation and efficient-izing] can be carried out in this way, and can be carried out.

[0096] [Deformation of the gestalt of the 4th operation and modification] In addition, naturally, various deformation and modification ([deformation of the gestalt of the 2nd operation and modification] are included including [deformation of the gestalt of the 2nd operation and modification] including [deformation of the gestalt of the 1st operation and modification]) are possible for each configuration of the gestalt of this 4th operation like the 1st, 2nd, and 3rd operation gestalt. [4-1] Deformation as followed, for example, shown in after-mentioned drawing 16 and 17 is also possible. This invention may be carried out in this way, and may be carried out.

[0097] [5th configuration of the gestalt of operation] Next, the gestalt of operation of the 5th of the electrophoresis component of this invention is shown. In the electrophoresis component which constituted two or more liquid flow channels for the plate which carried out recessing of this operation gestalt in piles The passage section for impregnation which injects into this separation component the sample separated with this electrophoresis component at least, It is the electrophoresis component of which the separation column section which separates this sample crosses and consists. It has the front face of F-potential where this a part of separation column section inside [at least] differs from the F-potential of the substrate passage inside which carried out recessing. Furthermore, the front face of different F-potential will be made to be constituted by the F-potential of the substrate which carried out recessing by the insulating inorganic material. The gestalt of this operation can also be caught with the modification of the

gestalt of said 1st operation, and can also be caught with the modification of the gestalt (the example of deformation of the gestalt of the 2nd operation and modification is included) of said 2nd operation, for example. The sectional view of the electrophoresis component 60 where drawing 12 followed the gestalt of this 4th operation, and drawing 13 are drawings which looked at the substrate in that electrophoresis component 60 which carried out recessing from the recessing side.

[0098] If it explains hereafter based on the illustrated example, the electrophoresis component 20 which this electrophoresis component 69 showed to the 2nd operation gestalt here, and its structure are similar, and it has the composition of not having the reagent inlet 9 for surface treatment in the electrophoresis component 20. Similarly, the electrophoresis component 60 joins the borosilicate glass substrate 62 which carried out recessing to the borosilicate glass substrate 61, and is constituted again. Passage 63 is formed of the space surrounded by the substrate 61 and the substrate 62 which has a slot.

[0099] Passage 63 is passage which has six branch separations here, The support liquid inlet 5, the support liquid exhaust port 6, the sample inlet 7, the sample exhaust port 8, and two sample preparative isolation openings 24 (24a, 24b) are constituted. The connector with a tube is formed in each opening, and the electrode 10 which consists of tubing-like platinum is connected. moreover The separation column section which connects the support liquid exhaust port 6 crosses by the intersection 11 from the passage section for impregnation which connects the sample exhaust port 8 from the sample inlet 7, and the support liquid inlet 5. Moreover, the passage section for preparative isolation which connects preparative isolation opening 24a to preparative isolation opening 24b to the separation column section which connects the support liquid exhaust port 6 from the support liquid inlet 5 crosses by the intersection 25. Moreover, the separation column section which connects the support liquid exhaust port 6 from the support liquid inlet 5 has the configuration where it moved in a zigzag direction between the intersection 11 and the intersection 25.

[0100] Drawing 13 is drawing which looked at the above-mentioned substrate 62 which carried out recessing from the recessing side. Passage 63 has the passage wall 64 by which the coat was carried out with silicon-dioxide glass. The part of this passage wall 64 works as a separation column.

[0101] The creation approach of the above-mentioned electrophoresis component 60 used the general photolithography technique, the etching technique, and the membrane formation technique. Creation of the passage wall 64 is obtained by forming a silicon dioxide by sputtering after the wet etching of this drawing (d) of the production approach shown in drawing 3 . Moreover, the borosilicate glass substrate 61 put on the borosilicate glass substrate 62 which carried out recessing also forms and constitutes a silicon dioxide into the part which constitutes the passage wall 64 using a photolithography technique, an etching technique, and a membrane formation technique.

[0102] Next, separation / preparative isolation experiment using this electrophoresis component 60 is explained. First, a high voltage power supply is connected to six electrodes 10. In the electrode of the support liquid inlet 5, the sample inlet 7, and preparative isolation opening 24a, they are the support liquid exhaust port 6 and the sample exhaust port 8 about an anode plate, Cathode is connected to the electrode of preparative isolation opening 24b. The migration buffer is beforehand filled to the whole in

passage 63.
[0103] Next, the sample for separating into the sample inlet 7 is poured in. An electrical potential difference is impressed between the sample inlet 7 and the sample exhaust port 8, and a sample is introduced toward the sample exhaust port 8 from the sample inlet 7 by the electroendosmose style. Next, an electrical potential difference is impressed between the support liquid inlet 5 and the support liquid exhaust port 6, and the sample which exists in an intersection 11 is made to migrate toward the support liquid exhaust port 6 by the electroendosmose style. A migration sample migrates toward the support liquid exhaust port 6, dissociating through the passage which has the passage 64 by which surface treatment was carried out on the way.
[0104] Here, a separation condition is detected using the detection system of the separation matter which is not illustrated in the support liquid inlet 5 side of an intersection 25 or an intersection 25. In case the separation matter for the purpose of preparative isolation passes an intersection 25, impress an electrical potential difference to the question of preparative isolation opening 24a and preparative isolation opening 24b, only this separation matter is made to migrate toward preparative isolation opening 24b, and it isolates preparatively.
[0105] [An operation and effectiveness] of the gestalt of the 5th operation Next, an operation and effectiveness of the gestalt of this 5th operation are explained. The F-potential of the passage wall of the passage 64 used as the passage to which the sample exhaust port 8 is connected, and the separation column section by which the surface coat was carried out differs from the sample inlet 7 where the above-mentioned electrophoresis component 60 serves as sample induction. Moreover, the F-potential of a passage wall with the passage section for preparative isolation which connects preparative isolation opening 24a to preparative isolation opening 24b used for the aliquot of the separation matter to passage 64 differs. The wall of sample induction and the passage section for preparative isolation is a borosilicate glass front face, and the sign of F-potential serves as negative from a surface electric charge condition. Although the sign of F-potential serves as negative from a surface electric charge condition on the other hand in the wall of passage 64 which works as a separation column Since it is covered with silicon-dioxide glass without movable ion, the absolute value of F-potential becomes small compared with a borosilicate glass front face., Therefore, the above-mentioned electrophoresis component 60 has the operation and effectiveness shown in the 1st and 2nd operation gestalt.
[0106] Moreover, in addition to the operation and effectiveness shown in the 1st and 2nd operation gestalt, the above-mentioned electrophoresis component 60 has the following operation and effectiveness. Since the wall of the passage 64 by which the surface coat was carried out is an inorganic coat, even if its endurance is high and it performs washing by alkali etc., it does not deteriorate like organic coating. for this reason, endurance is high -- it becomes an usable electrophoresis component repeatedly.
[0107] Moreover, since the electrophoresis component 60 can apply and create a semi-conductor process technique as indicated to the above-mentioned creation approach, the fluid passage for instrumental analyses which can miniaturize ****** passage can be offered. In this way, if the configuration of the gestalt of this operation is followed, high separation and efficient-izing are possible, and it can miniaturize and the electrophoresis component for instrumental analyses which has a wall for surface

qualification with high endurance further again will be realized. This invention can be carried out in this way, and can also be carried out.
[0108] [Modification of the gestalt of the 5th operation and deformation] In addition, naturally, various deformation and modification ([modification of the gestalt of the 1st operation and deformation] are included) are possible for each configuration of the gestalt of this 5th operation.
[5-1] Moreover, for example, if the silicon-dioxide glass which has covered the front face of passage 64 is an insulating inorganic material, it can be changed into other inorganic coat ingredients. For example, it can change into other glass ingredients, silicon nitride, an alumina, a diamond, tantalum pentoxide, etc.
[5-2] Moreover, although the electrophoresis component 60 has composition without the reagent inlet 9 for surface treatment in the electrophoresis component 20 shown in the 2nd operation gestalt, it can also be considered as a configuration without the electrophoresis components 1 and 30 shown in the 1st, 3rd, and 4th operation gestalt, 40, and the reagent inlet 9 for surface treatment in 50.
[0109] [5-3] For example, the perspective view of the electrophoresis component 70 which is the example of modification of the electrophoresis component 40 of the 3rd operation gestalt is shown in drawing 14 . This electrophoresis component 70 has composition without the reagent inlet 9 for surface treatment in the electrophoresis component 40. Drawing 15 is drawing which looked at the substrate 72 in the above-mentioned electrophoresis component 70 which carried out recessing from the recessing side. Passage 73 has ** 74 and 75 in passage by which the coat was carried out with silicon-dioxide glass. The part of these passage walls 74 and 75 works as a separation column. 71 show the substrate of another side among drawing 14 and 15, and other reference marks apply to the thing of the reference mark (drawing 1 - drawing 9 are included) already used to explanation of this 5th operation gestalt.
[0110] [5-4] Moreover, the perspective view of the electrophoresis component 80 which is the example of modification of the electrophoresis component 50 of the 4th operation gestalt is shown in drawing 16 . This electrophoresis component 80 has composition without the reagent inlet 9 for surface treatment in the electrophoresis component 50. Drawing 17 is drawing which looked at the substrate 82 in the above-mentioned electrophoresis component 80 which carried out recessing from the recessing side. Passage 83 has the passage wall 85 by which the coat was carried out with the passage wall 84 by which the coat was carried out with silicon-dioxide glass, and silicon nitride. The part of these passage walls 84 and 85 works as a separation column. 81 show the substrate of another side among drawing 16 and 17, and other reference marks apply to the thing of the reference mark (drawing 1 - drawing 11 are included) already used to explanation of this 5th operation gestalt.
[0111] The 5th operation gestalt can also be caught with the modification of the gestalt of said 3rd operation, and the modification of the gestalt of said 4th operation. This invention may be carried out in this way, and may be carried out.
[0112] The contents indicated by the gestalt of each above operation, deformation, the example of modification, etc. can also be regarded as the following invention.
[0113] [Additional remark term 1] In the electrophoresis component which constituted two or more liquid flow channels for the plate which carried out recessing in piles The passage section for impregnation which injects into this separation component the

sample separated with this electrophoresis component at least. The electrophoresis component which is an electrophoresis component of which the separation column section which separates this sample crosses and consists, and is characterized by this a part of separation column section inside [at least] having the front face of different F-potential from the F-potential of this passage section inside for impregnation (gestalt of the 1st operation).

[0114] [Additional remark term 2] In an electrophoresis component given in [the additional remark term 1], the value of a part of [at least] F-potential of this separation column section inside and the value of the F-potential of this passage section inside for impregnation are 0 or the same sign. The electrophoresis component to which the absolute value of a part of [at least] F-potential of this separation column section inside is characterized by being smaller than the absolute value of the F-potential of this passage section inside for impregnation (gestalt of the 1st operation).

[0115] [Additional remark term 3] In an electrophoresis component given in [additional remark term 1]- [the additional remark term 2] It is the electrophoresis component of which the separation column section which separates a sample, and the passage section for preparative isolation which isolates this separated sample preparatively cross and consist with this electrophoresis component at least. The electrophoresis component characterized by this a part of separation column section inside [at least] having the front face of different F-potential from the F-potential of this passage inside for preparative isolation (gestalt of the 2nd operation).

[0116] [Additional remark term 4] In an electrophoresis component given in [the additional remark term 3], the value of a part of [at least] F-potential of this separation column section inside and the value of the F-potential of this passage section inside for preparative isolation are 0 or the same sign. The electrophoresis component to which the absolute value of a part of [at least] F-potential of this separation column section inside is characterized by being smaller than the absolute value of the F-potential of this passage section inside for preparative isolation (gestalt of the 2nd operation).

[0117] [Additional remark term 5] It is the electrophoresis component which has two or more these passage sections for preparative isolation in an electrophoresis component given in [the additional remark term 3]. This at least one passage section for preparative isolation is constituted by the location of the arbitration of this separation column section. The electrophoresis component to which a part of [at least] F-potential of the separation column section inside of both ends is characterized by having the front face of different F-potential from the F-potential of this passage inside for preparative isolation bordering on this style **** for preparative isolation (gestalt of the 3rd operation).

[0118] [Additional remark term 6] In an electrophoresis component given in [the additional remark term 3], the value of a part of [at least] F-potential of this separation column section inside and the value of the F-potential of this passage section inside for preparative isolation are 0 or the same sign. The electrophoresis component to which the absolute value of a part of [at least] F-potential of this separation column section inside is characterized by being smaller than the absolute value of the F-potential of this passage section inside for preparative isolation (gestalt of the 3rd operation).

[0119] [Additional remark term 7] Electrophoresis component characterized by preparing the passage section for electrical-potential-difference impression in the passage section

side for impregnation of the separation column section inserted into two or more passage sections for preparative isolation in [the additional remark term 5] and an electrophoresis component given in [the additional remark term 6] (gestalt of the 4th operation).
[0120] [Additional remark term 8] Electrophoresis component characterized by the values of the F-potential of this separation column section inside differing in an electrophoresis component given in [the additional remark term 7] bordering on this passage section for preparative isolation constituted by the location of the arbitration of this separation column section (gestalt of the 4th operation).
[0121] [Additional remark term 9] The value of the F-potential of a separation column section inside which is different bordering on this passage section for preparative isolation in an electrophoresis component given in [the additional remark term 8] is 0 or the same sign. The electrophoresis component characterized by this passage section side for impregnation having the absolute value of the F-potential of the separation column section inside located in this passage section side for impregnation larger than the absolute value of the F-potential of the separation column section inside located in the opposite side (gestalt of the 4th operation).
[0122] [Additional remark term 10] In the electrophoresis component which constituted two or more liquid flow channels for the plate which carried out recessing in piles The passage section for impregnation which injects into this separation component the sample separated with this electrophoresis component at least, It is the electrophoresis component of which the separation column section which separates this sample crosses and consists. It has the front face of F-potential where this a part of separation column section inside [at least] differs from the F-potential of the substrate passage inside which carried out recessing. The electrophoresis component to which the front face of different F-potential from the F-potential of the substrate which carried out recessing is characterized by being constituted with the insulating inorganic material (gestalt of the 4th operation).
[0123] [Additional remark term 11] Electrophoresis component characterized by this insulating inorganic material consisting of glass ingredients, such as silica glass and HOUKEI acid glass, or silicon nitride, tantalum pentoxide, an alumina, and a diamond in an electrophoresis component given in [the additional remark term 10] (gestalt of the 5th operation).
[0124]
[Effect of the Invention] According to this invention, the electrophoresis component for instrumental analyses which can be miniaturized is advantageously realizable possible [high separation and efficient-izing]. Moreover, the electrophoresis component for instrumental analyses which has a surface qualification wall with high endurance is advantageously realizable.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective view of the electrophoresis component concerning the gestalt of operation of the 1st of this invention.
[Drawing 2] It is drawing which looked at the substrate in the electrophoresis component in the gestalt of this operation which carried out recessing from the recessing side.
[Drawing 3] It is drawing with which explanation of an example of the production approach of the electrophoresis component in the gestalt of this operation is presented.
[Drawing 4] It is the perspective view of the electrophoresis component concerning the gestalt of operation of the 2nd of this invention.
[Drawing 5] It is drawing which looked at the substrate in the electrophoresis component in the gestalt of this operation which carried out recessing from the recessing side.
[Drawing 6] It is drawing showing the electrophoresis component concerning the example of modification in this example.
[Drawing 7] It is drawing which looked at the substrate in the electrophoresis component in this example of modification which carried out recessing from the recessing side.
[Drawing 8] It is the perspective view of the electrophoresis component concerning the gestalt of operation of the 3rd of this invention.
[Drawing 9] It is drawing which looked at the substrate in the electrophoresis component in the gestalt of this operation which carried out recessing from the recessing side.
[Drawing 10] It is the perspective view of the electrophoresis component concerning the gestalt of operation of the 4th of this invention.
[Drawing 11] It is drawing which looked at the substrate in the electrophoresis component in the gestalt of this operation which carried out recessing from the recessing side.
[Drawing 12] It is the sectional view of the electrophoresis component concerning the gestalt of operation of the 5th of this invention.
[Drawing 13] It is drawing which looked at the substrate in the electrophoresis component in the gestalt of this operation which carried out recessing from the recessing side.
[Drawing 14] It is the perspective view of the electrophoresis component by the example of modification of the electrophoresis component concerning the gestalt of operation of the 3rd of this invention.
[Drawing 15] Similarly, it is drawing which looked at the substrate in the electrophoresis

component in this example of modification which carried out recessing from the recessing side.

[Drawing 16] It is the perspective view of the electrophoresis component by the example of modification of the electrophoresis component concerning the gestalt of operation of the 4th of this invention.

[Drawing 17] Similarly, it is drawing which looked at the substrate in the electrophoresis component in this example of modification which carried out recessing from the recessing side.

[Drawing 18] It is the schematic diagram of the electrophoresis apparatus with which explanation of the advanced technology is presented.

[Description of Notations]

1 Electrophoresis Component
2 Borosilicate Glass Substrate
3 Borosilicate Glass Substrate
4 Passage
5 Support Liquid Inlet
6 Support Liquid Exhaust Port
7 Sample Inlet
8 Sample Exhaust Port
9, 9a, 9b, 9c, 9d Reagent inlet for surface treatment
10 Electrode
11 Intersection
12 Passage (Passage Wall)
13 Resist Thin Film
14 Slot
15 Heater
16 Connector
17 Tube
20 Electrophoresis Component
21 Borosilicate Glass Substrate
22 Borosilicate Glass Substrate
23 Passage
24, 24a, 24b Sample preparative isolation opening
25 Intersection
30 Electrophoresis Component
31 Borosilicate Glass Substrate
32 Borosilicate Glass Substrate
33 Passage
34 Passage (Passage Wall)
35 Passage (Passage Wall)
40 Electrophoresis Component
41 Borosilicate Glass Substrate
42 Borosilicate Glass Substrate
43 Passage
44, 44a, 44b Sample preparative isolation opening
45 Intersection

46 Passage (Passage Wall)
47 Passage (Passage Wall)
50 Electrophoresis Component
51 Borosilicate Glass Substrate
52 Borosilicate Glass Substrate
53 Passage
54 Passage Opening for Electrical-Potential-Difference Impression
55 Passage (Passage Wall)
60 Electrophoresis Component
61 Borosilicate Glass Substrate
62 Borosilicate Glass Substrate
63 Passage
64 Passage (Passage Wall)
70 Electrophoresis Component
71 Borosilicate Glass Substrate
72 Borosilicate Glass Substrate
73 Passage
74 Passage (Passage Wall)
75 Passage (Passage Wall)
80 Electrophoresis Component
81 Borosilicate Glass Substrate
82 Borosilicate Glass Substrate
83 Passage
84 Passage (Passage Wall)
85 Passage (Passage Wall)

[Translation done.]

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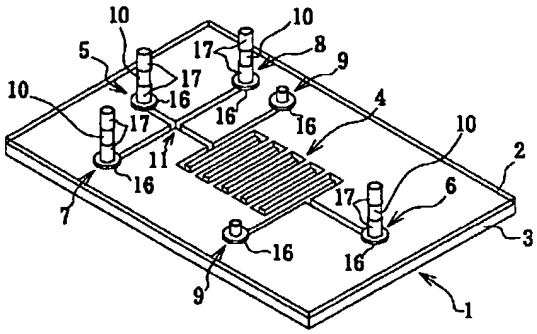
(54)【発明の名称】　電気泳動素子

(57)【要約】
【課題】　高分離・高効率化が可能で、且つ小型化が可能であり、また、耐久性の高い表面修飾内壁を有する機器分析用電気泳動素子を提供する。
【解決手段】　電気泳動素子１は、注入用流路部と分離カラム部とが交差し、分離カラム部内面の少なくとも一部分が、注入用流路部内面のゼータ電位とは異なるゼータ電位の表面を有している。注入用流路部は電気浸透流が速いため試薬導入が短時間で済み且つカラムに入れる前に試薬の分離を防ぎ、分離カラム部のみ電気浸透流を遅くして分離効率を上げることが可能となる。電気泳動素子１は分離カラム部のみのゼータ電位の絶対値を小さくすることによって、高分離・高効率化が可能な機器分析用流体流路を提供することができる。また、電気泳動素子１は半導体プロセス技術を応用して作成することが可能であり、微細な流路の小型化が可能である。



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【特許請求の範囲】

【請求項１】　溝加工した平板を複数重ねて液流路を構成した電気泳動素子において、少なくとも該電気泳動素子にて分離する試料を該分離素子に注入する注入用流路部と、該試料を分離する分離カラム部とが交差して成る電気泳動素子であって、該分離カラム部内面の少なくとも一部分が、該注入用流路部内面のゼータ電位とは異なるゼータ電位の表面を有していることを特徴とする電気泳動素子。

【請求項２】　請求項１記載の電気泳動素子において、少なくとも該電気泳動素子にて試料を分離する分離カラム部と、分離した該試料を分取する分取用流路部とが交差して成る電気泳動素子であって、該分離カラム部内面の少なくとも一部分が、該分取用流路内面のゼータ電位とは異なるゼータ電位の表面を有していることを特徴とする電気泳動素子。

【請求項３】　請求項２記載の電気泳動素子において、該分取用流路部を複数有する電気泳動素子であって、少なくとも一つの該分取用流路部が該分離カラム部の任意の位置に構成され、該分取用流路部を境に両端の分離カラム部内面の少なくとも一部分のゼータ電位が、該分取用流路内面のゼータ電位とは異なるゼータ電位の表面を有していることを特徴とする電気泳動素子。

【請求項４】　請求項３記載の電気泳動素子において、複数の分取用流路部に挟まれた分離カラム部の注入用流路部側に電圧印加用流路部が設けられていることを特徴とする電気泳動素子。

【請求項５】　溝加工した平板を複数重ねて液流路を構成した電気泳動素子において、少なくとも該電気泳動素子にて分離する試料を該分離素子に注入する注入用流路部と、該試料を分離する分離カラム部とが交差して成る電気泳動素子であって、該分離カラム部内面の少なくとも一部分が、溝加工した基板流路内面のゼータ電位とは異なるゼータ電位の表面を有しており、その溝加工した基板のゼータ電位とは異なるゼータ電位の表面が、絶縁性の無機材料によって構成されていることを特徴とする電気泳動素子。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、電気泳動素子に関し、特に、機器分析用流体流路に適用して好適な機器分析用電気泳動素子に関するものである。

【０００２】

【従来の技術】機器分析用流体流路は、従来、ガラスやステンレスなどの細管を用いて行われている。該細管は分析能力を向上させるために通常５０ｃｍの長さの細管が用いられており、この長さの細管を円状に丸めて使用しているため小型化が困難であった。また、従来の機器分析用流体流路は分離能向上を目的として表面処理が行われているが、一本の細管で構成されているため部分的

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に表面処理を行うことは不可能であった。

【０００３】上記課題を解決する手段として、半導体プロセス技術によって、シリコンウェハやガラスなどに微細な溝を構成する手段が報告されている。例えば、特開平９－８９８４０号公報（文献１）には、シリコンまたはガラス基板に溝を加工して液流路を形成し、その流路を所望物質で部分的に修飾して高感度な分析が効率よく行えるようにした小型電気泳動装置が報告されている。

【０００４】図１８は、該電気泳動装置の概略図を示す。図中、符号１０１，１０２，１０３，１０５，１０８，１０９，１１０は、液流入、流出の用に供することのできる液路口を、また符号１０６は流路を表す。該電気泳動装置は、エッチングによって一方の基板１１７に溝（流路１０６）を形成し他方の基板（不図示）を接合して素子を形成している。基板１１７の溝から成る液流路１０６は、途中（参照符号１０７，１１２部分）に部分的に液を流すための液の流入・流出口が設けられており（図示例では流入・流出口１０１，１０９及び１０２，１０８の組が配置されている）、表面修飾剤を部分的に流して流路内壁を部分的に表面修飾できるように構成されている。

【０００５】表面修飾剤としては種々のシランカップリング剤が用いられており、シランカップリング剤が有する感応基の種類によって分離物質とのアフィニティを変え分離効率を重畳させることができる。この表面修飾によって、より高感度な分析が効率よく行えると報告されている。

【０００６】

【発明が解決しようとする課題】上記先行技術において、部分的な表面修飾による高分離・高効率化の効果が報告されているが、その内容は具体性に欠け、特に高効率化についてはその具体的記載がされていない。

【０００７】また、シランカップリング剤による表面修飾は有機被膜を利用しているため、有機溶媒やアルカリによる洗浄によって皮膜の劣化が生じ、耐久性に乏しいという問題点を有する。

【０００８】したがって、本発明は、上記問題を解決すべくなされたもので、その目的は、高分離・高効率化が可能であって、且つ小型化が可能な機器分析用電気泳動素子を提供することにある。また、耐久性の高い表面修飾内壁を有する機器分析用電気泳動素子を提供することにある。

【０００９】

【課題を解決するための手段】本発明によって、以下の電気泳動素子が提供される。すなわち、溝加工した平板を複数重ねて液流路を構成した電気泳動素子において、少なくとも該電気泳動素子にて分離する試料を該分離素子に注入する注入用流路部と、該試料を分離する分離カラム部とが交差して成る電気泳動素子であって、該分離カラム部内面の少なくとも一部分が、該注入用流路部内

面のゼータ電位とは異なるゼータ電位の表面を有していることを特徴とする電気泳動素子が提供される（請求項１）。

【００１０】ここに、請求項１中の「溝加工した平板」は、本発明の好ましい第１の実施の形態（第１の実施の形態の変形、変更例を含む。以下同じ。）では、例えばホウケイ酸ガラス基板が該当するが、他の素材のガラス基板やシリコンウエハ、また、プラスチック基板なども含む。請求項１中の「溝加工した平板」を構成する溝は、この第１の実施の形態では、例えばウエットエッチングにより形成したが、ドライエッチングや機械加工など、他の手法で形成することもできる。また、第１の実施の形態の溝の形状は、該形状に限定する必要はなく、他の形状であっても良い。また、第１の実施形態では、一方の基板のみに溝を構成したが、他方の基板側にも同様に溝を構成することも可能である。溝を構成する基板の数は限定されず、複数枚重ねて溝を構成することも可能である。また、貫通加工した基板と未加工の平板とを重ねて構成することもできる。溝の深さまたは幅は電圧を印加した際に電気浸透流が発生する範囲、具体的には１５０μｍ以下であることが望ましい。請求項１中の「分離する試料を該分離素子に注入する注入用流路部」は、第１の実施の形態では試料注入口から試料排出口を結ぶ流路が該当する。請求項１中の「該試料を分離する分離カラム部」は、第１の実施の形態では支持液注入口から支持液排出口を結ぶ流路が該当する。請求項１中の「注入用流路部内面のゼータ電位」は、この第１の実施の形態では、例えばホウケイ酸ガラス表面のゼータ電位が該当する。請求項１中の「注入用流路部内面のゼータ電位とは異なるゼータ電位の表面」は、この第１の実施の形態では、例えばトリメチルクロロシランによって表面処理された流路内壁が該当するが、他の一般的表面処理剤、例えば、他のシランカップリング剤や、カルボキシメチルセルロースやポリアクリルアミドなどの親水性高分子や界面活性剤等なども含む。

【００１１】本発明に従う電気泳動素子の作用、効果は、以下のように説明することができる。キヤピラリー電気泳動においてはキヤピラリーに支持液として電解質溶液を満たして分析を行うが、このことによりキヤピラリー内壁及びこれと接する電解質溶液の間に電気二重層が形成される。ここに電圧が印加されると電解質溶液が溶媒を伴って移動し、電気浸透流が生じる。電気浸透流は分離された成分イオンを移動させる駆動力として利用することができる。電気浸透流速υは電解質溶液の誘電率εと粘性率η、ゼータ電位ζおよびキヤピラリーに沿ってかけられる電場の強さＥの関係として下記式で表される。ゼータ電位とはキヤピラリー内壁と電解質溶液管の電位差のことである。

【数１】$$\upsilon = -(\varepsilon\zeta/\eta)E \quad \cdots\cdots (1)$$

【００１２】ゼータ電位ζはキヤピラリー内壁の荷電状態において正負いずれの符号をもとりうるが、通常用キヤピラリーに用いられるガラス表面では負になるため、υは正となり、従って電気浸透流は陽極から陰極へ向かう。

【００１３】ここに、本発明に従う電気泳動素子は、試料導入部となる注入用流路部と分離カラムとして働く表面処理された流路との流路内壁のゼータ電位が異なる。注入用流路部の内壁はホウケイ酸ガラス表面であり、ゼータ電位の符号は表面の荷電状態から負となる。一方、分離カラムとして働く表面処理された流路の内壁は非イオン性の表面処理剤にて覆われているため表面の荷電は弱くなり、ゼータ電位の絶対値は表面未処理の流路内壁に比べ小さくなる。

【００１４】ところで、上記（１）式から、電圧を印加した際の電気浸透流の速さは、ゼータ電位の絶対値が大きいほど速い。つまり、本発明の電気泳動素子の電気浸透流は試薬の注入用流路部が速く分離カラム部が遅いことになる。電気浸透流が速いと分析時間が少なくて済む反面、分離効率が悪い。表面処理により電気浸透流が抑えられると分析時間が長くなるものの分離効率が向上する。この現象は、例えば「本田進、寺部茂：キヤピラリー電気泳動，Ｐ２６；講談社」（文献２）に説明されている。従って、本発明の電気泳動素子は、注入用流路部は電気浸透流が速いため試薬導入が短時間で済み且つカラムに入れる前に試薬の分離を防ぎ、分離カラム部のみ電気浸透流を遅くして分離効率を上げることが可能となる。つまり、本発明の電気泳動素子は分離カラム部のみのゼータ電位の絶対値を小さくすることによって、高分離・高効率化が可能な機器分析用流体流路を提供することができる。また、第１の実施の形態の作成方法に記載するように、本発明の電気泳動素子は半導体プロセス技術を応用して作成することが可能であるため、微細な流路の小型化が可能な機器分析用流体流路を提供することができる。

【００１５】本発明はまた、請求項１記載の電気泳動素子において、該分離カラム部内面の少なくとも一部分のゼータ電位の値と該注入用流路部内面のゼータ電位の値とが０または同一符号であり、該分離カラム部内面の少なくとも一部分のゼータ電位の絶対値が、該注入用流路部内面のゼータ電位の絶対値よりも小さいようにする構成として、好適に実施でき（第１変形例）、同様にして、上記請求項１による場合と同様の作用効果を得ることができる。この場合において、「分離カラム部内面の少なくとも一部分のゼータ電位の値」とは、第１の実施の形態では、トリメチルクロロシランによって表面処理された流路内壁のゼータ電位の値が該当する。「注入用流路部内面のゼータ電位の値」とは、第１の実施の形態では、ホウケイ酸ガラス基板のゼータ電位の値が該当する。

【００１６】また、請求項１（または第１変形例）記載

の電気泳動素子において、少なくとも該電気泳動素子にて試料を分離する分離カラム部と、分離した該試料を分取する分取用流路部とが交差して成る電気泳動素子であって、該分離カラム部内面の少なくとも一部分が、該分取用流路内面のゼータ電位とは異なるゼータ電位の表面を有していることを特徴とする電気泳動素子が、本発明により提供される（請求項２）。

【００１７】ここに、請求項２中の「試料を分離する分離カラム部」とは、後述の第２の実施の形態（第２の実施の形態の変形、変更例を含む）では支持液注入口から支持液排出口を結ぶ流路が該当する。請求項２中の「分離した該試料を分取する分取用流路部」とは、この第２の実施形態では、二つの分取口を結ぶ流路が該当する。請求項２中の「分取用流路内面のゼータ電位」とは、この第２の実施形態では、例えばホウケイ酸ガラス表面のゼータ電位が該当する。請求項２中の「分取用流路内面のゼータ電位とは異なるゼータ電位の表面」とは、この第２の実施形態では、例えばトリメチルクロロシランによって表面処理された流路内壁が該当する。

【００１８】請求項２の場合、本発明の電気泳動素子は、請求項１記載の電気泳動素子の作用・効果に加え、下記作用・効果を有する。本発明の電気泳動素子は、分離カラムとして働く表面処理された流路と、分離物質の分取に用いる分取用流路部との流路内壁のゼータ電位が異なる。分取用流路部の内壁はホウケイ酸ガラス表面であり、ゼータ電位の符号は表面の荷電状態から負となる。一方、分離カラムとして働く表面処理された流路の内壁は非イオン性の表面処理剤にて覆われているため表面の荷電は弱くなり、ゼータ電位の絶対値は表面未処理の流路内壁に比べ小さくなる。

【００１９】ここで、前記（１）式から、電圧を印加した際の電気浸透流の速さは、ゼータ電位の絶対値が大きいほど速い。つまり、本発明の電気泳動素子は分取用流路部が速く分離カラム部が遅いことになる。電気浸透流が速いと分析時間が少なくて済む反面、分離効率が悪い。表面処理により電気浸透流が抑えられると分析時間が長くなるものの分離効率が向上する。従って、本発明の電気泳動素子は、分離カラム部のみ電気浸透流を遅くして分離効率を上げ、分取用流路部は電気浸透流が速いため分取を短時間で行うことができ且つ分取前に試薬の分離を防ぐことが可能となる。つまり、本発明の電気泳動素子は分離カラム部のみのゼータ電位の絶対値を小さくすることによって、高分離・高効率化が可能な機器分析用流体流路を提供することができる。また、本発明の電気泳動素子は半導体プロセス技術を応用して作成することが可能であるため、微細な流路の小型化が可能な機器分析用流体流路を提供することができる。

【００２０】本発明はまた、請求項２記載の電気泳動素子において、該分離カラム部内面の少なくとも一部分のゼータ電位の値と該分取用流路部内面のゼータ電位の値とが０または同一符号であり、該分離カラム部内面の少なくとも一部分のゼータ電位の絶対値が、該分取用流路部内面のゼータ電位の絶対値よりも小さいようにする構成として、好適に実施でき（第２変形例）、同様にして、上記請求項２による場合と同様の作用効果を得ることができる。この場合において、「分離カラム部内面の少なくとも一部分のゼータ電位の値」とは、第２の実施の形態ではトリメチルクロロシランによって表面処理された流路内壁のゼータ電位の値が該当する。「分取用流路部内面のゼータ電位の値」とは、第２の実施の形態ではホウケイ酸ガラス基板のゼータ電位の値が該当する。

【００２１】また、請求項２記載の電気泳動素子において、該分取用流路部を複数有する電気泳動素子であって、少なくとも一つの該分取用流路部が該分離カラム部の任意の位置に構成され、該分取用流路部を境に両端の分離カラム部内面の少なくとも一部分のゼータ電位が、該分取用流路内面のゼータ電位とは異なるゼータ電位の表面を有していることを特徴とする電気泳動素子が、本発明により提供される（請求項３）。

【００２２】ここに、請求項３中の「分離カラム部の任意の位置に構成された少なくとも一つの分取用流路部」とは、後述の第３の実施の形態（第３の実施の形態の変形、変更例を含む）では、分離カラム部の中央を交差する分取用流路部が該当するが、交差する位置は分離カラム部の位置は限定されず任意の位置に構成することができる。また、分離カラム部の任意の位置に構成された分取用流路部の数も限定されない。請求項３中の「分取用流路内面のゼータ電位」は、この第３の実施の形態では、例えばホウケイ酸ガラス表面のゼータ電位が該当する。請求項３中の「分取用流路内面のゼータ電位とは異なるゼータ電位の表面」は、この第３の実施の形態では、例えばトリメチルクロロシランによって表面処理された流路内壁が該当する。また、該分取用流路部を境に両端の分離カラムはそれぞれが異なる表面処理を施し異なるゼータ電位とすることが可能であり、また同じ表面処理を施すことも可能である。

【００２３】請求項３の場合、本発明の電気泳動素子は、請求項１、請求項２記載の電気泳動素子の作用・効果に加え、下記作用・効果を有する。本発明の電気泳動素子は、分離カラム部の中央を交差する第１の分取用流路部を境に、分離カラムとして働く表面処理された第１の流路と第２の流路を有し、さらに分離物質の泳動末端となる支持液排出口側に分離物質の分取に用いる第２の分取用流路部が構成されている。２つの分取用流路部の内壁はホウケイ酸ガラス表面であり、ゼータ電位の符号は表面の荷電状態から負となる。表面処理された２つの流路の内壁は非イオン性の表面処理剤にて覆われているため表面の荷電は弱くなり、ゼータ電位の絶対値は表面未処理の流路内壁に比べ小さくなる。表面処理された２つの流路は、同一の表面処理剤によって処理されてお

り、流路内壁のゼータ電位は等しい。

【００２４】ここで、前記（１）式から、電圧を印加した際の電気浸透流の速さは、ゼータ電位の絶対値が大きいほど速い。つまり、本発明の電気泳動素子の電気浸透流は２つの分取用流路部が速く２つの分離カラム部が遅いことになる。電気浸透流が速いと分析時間が少なくて済む反面、分離効率が悪い。表面処理により電気浸透流が抑えられると分析時間が長くなるものの分灘効率が向上する。注入口側に位置する表面処理された第 1の流路にて目的の分離が生じた場合は、その時点で第１の分取用流路部にて分取目的の分離物質を分取できるため、分離から分取までが速くなる。また、注入口側に位置する表面処理された流路では分離不十分だった場合は、さらに第２の流路にて分離させ第２の分取用流路部から分取目的の分離物質を分取できる。このように、本発明の電気泳動素子は試料の分離過程において、分離に応じて分取することが可能となり、効率良く分離・分取を進めることができる。つまり、本発明の電気泳動素子はゼータ電位の絶対値の小さい２つの分離カラム部の間と泳動末端部にゼータ電位の絶対値の大きい分取用流路部を設けることによって、高分離・高効率化が可能な機器分析用流体流路を提供することができる。また、半導体プロセス技術を応用して作成することが可能であるため、微細な流路の小型化が可能な機器分析用流体流路を提供することができる。

【００２５】本発明はまた、請求項３記載の電気泳動素子において、該分離カラム部内面の少なくとも一部分のゼータ電位の値と該分取用流路部内面のゼータ電位の値とが０または同一符号であり、該分離カラム部内面の少なくとも一部分のゼータ電位の絶対値が、該分取用流路部内面のゼータ電位の絶対値よりも小さいようにする構成として、好適に実施でき（第３変形例）、同様にして、上記請求項３による場合と同様の作用効果を得ることができる。この場合において、「分離カラム部内面の少なくとも一部分のゼータ電位の値」とは、第３の実施の形態ではトリメチルクロロシランによって表面処理された流路内壁のゼータ電位の値が該当する。「分取用流路部内面のゼータ電位の値」とは、第３の実施の形態ではホウケイ酸ガラス基板のゼータ電位の値が該当する。

【００２６】また、請求項３（または第３変形例）記載の電気泳動素子において、複数の分取用流路部に挟まれた分離カラム部の注入用流路部側に電圧印加用流路部が設けられていることを特徴とする電気泳動素子が、本発明により提供される（請求項４）。

【００２７】ここに、請求項４中の「複数の分取用流路部」とは、後述の第４の実施の形態（第４の実施の形態の変形、変更を含む）では、分離カラム部のほぼ中央を交差する第１の分取用流路部と、分離物質の泳動末端となる支持液排出口側に構成された第２の分取用流路部の２つが該当する。請求項４中の「複数の分取用流路部に挟まれた分離カラム部」とは、この第４の実施の形態では、第１の分取用流路部と第２の分取用流路部との間に位置する第２の分離カラム部が該当する。請求項４中の「電圧印加用流路部」とは、この第４の実施の形態では、第１の分取用流路部と第２の分離カラム部との間に構成された電圧印加用流路口への分岐流路が該当する。

【００２８】請求項４の場合、本発明の電気泳動素子は、請求項１～３記載の電気泳動素子の作用・効果に加え、下記作用・効果を有する。本発明の電気泳動素子は、分離カラムとして働く表面処理された第１の流路と第２の流路を有し、２つの流路の間に分離物質の分取に用いる第１の分取用流路部と電圧印加ポイントを切り換えるために用いる電圧印加用流路口が構成され、さらに分離物質の泳動末端となる支持液排出口側に分離物質の分取に用いる第２の分取用流路部が構成されている。第１の流路、第２の流路及び２つの分取用流路部は、流路内壁のゼータ電位が異なる。２つの分取用流路部の内壁はホウケイ酸ガラス表面であり、ゼータ電位の符号は表面の荷電状態から負となる。表面処理された第１の流路と第２の流路の内壁は非イオン性の表面処理剤にて覆われているため表面の荷電は弱くなり、ゼータ電位の絶対値は表面未処理の分取用流路部内壁に比べ小さくなる。また、表面処理された第１の流路と第２の流路とは異なる表面処理剤で覆われているため、流路内壁のゼータ電位が異なる。第２の流路は第１の流路よりも疎水性の強い表面処理剤で覆われているため、表面の電荷は弱くなり、ゼータ電位の絶対値は第１の流路に比べさらに小さくなる。

【００２９】ここで、前記（１）式から、電圧を印加した際の電気浸透流の速さは、ゼータ電位の絶対値が大きいほど速い。つまり、本発明の電気泳動素子の電気浸透流は表面処理された第２の流路が最も遅く、表面処理された第 1の流路、２つの分取用流路部の順で速くなる。電気浸透流が速いと分析時間が少なくて済む反面、分離効率が悪い。表面処理により電気浸透流が抑えられると分析時間が長くなるものの分離効率が向上する。従って、表面処理された第１の流路は第２の流路に比べ分離効率は劣るものの分析時間は短い。表面処理された第１の流路にて目的の分離が生じた場合は、その時点で第１の分取用流路部にて分取目的の分離物質を分取できるため、分離から分取までが速くなる。また、表面処理された第１の流路では分離不十分だった場合は、さらに分離効率の高い表面処理された第２の流路にて分離させ第２の分取用流路部から分取目的の分離物質を分取できる。また、表面処理された第１の流路と第２の流路への電圧印加ポイントを切り換えて電圧印可することにより、表面処理の効果を反映した電気浸透流を実現することができる。つまり、本発明の電気泳動素子は、上記に説明したように、高分離・高効率化が可能な機器分析用流体流路を提供することができる。また、本発明の電気泳動素

子は半導体プロセス技術を応用して作成することが可能であるため、微細な流路の小型化が可能な機器分析用流体流路を提供することができる。

【００３０】本発明はまた、請求項４記載の電気泳動素子において、該分離カラム部の任意の位置に構成された該分取用流路部を境に、該分離カラム部内面のゼータ電位の値が異なるよう構成して、好適に実施でき（第４－１変形例）、同様にして、上記請求項４による場合と同様の作用効果を得ることができる。この場合において、「分離カラム部の任意の位置に構成された該分取用流路部」とは、第４の実施の形態では分離カラム部のほぼ中央を交差する分取用流路部が該当するが、交差する位置は分離カラム部の位置は限定されず任意の位置に構成することができる。「分離カラム部内面のゼータ電位の値」とは、第４の実施の形態ではトリメチルクロロシランによって表面処理された流路内壁とジメチルアロピルクロロシランによって表面処理された流路内壁のゼータ電位の値が該当する。さらにはまた、上記（第４－１変形例）記載の電気泳動素子において、該分取用流路部を境に異なる分離カラム部内面のゼータ電位の値が０または同一符号であり、該注入用流路部側に位置する分離カラム部内面のゼータ電位の絶対値が該注入用流路部側とは反対側に位置する分離カラム部内面のゼータ電位の絶対値よりも大きいようにする構成として、本発明は好適に実施でき（第４－２変形例）、同様にして、上記請求項４による場合と同様の作用効果を得ることができる。この場合において、「注入用流路部側に位置する分離カラム部」とは、第４の実施の形態ではトリメチルクロロシランによって表面処理された流路が該当する。「注入用流路部側とは反対側に位置する分離カラム部」とは、第４の実施の形態ではジメチルプロピルクロロシランによって表面処理された流路が該当する。

【００３１】また、本発明によると、溝加工した平板を複数重ねて液流路を構成した電気泳動素子において、少なくとも該電気泳動素子にて分離する試料を該分離素子に注入する注入用流路部と、該試料を分離する分離カラム部とが交差して成る電気泳動素子であって、該分離カラム部内面の少なくとも一部分が、溝加工した基板流路内面のゼータ電位とは異なるゼータ電位の表面を有しており、その溝加工した基板のゼータ電位とは異なるゼータ電位の表面が、絶縁性の無機材料によって構成されていることを特徴とする電気泳動素子が、提供される（請求項５）。

【００３２】ここに、請求項５中の「溝加工した平板」は、後述の第５の実施の形態（第５の実施の形態の変形、変更例を含む）では、例えばホウケイ酸ガラス基板が該当するが、他の素材のガラス基板やシリコンウエハ、また、プラスチック基板なども含む。請求項５中の「溝加工した平板」を構成する溝は、この第５の実施の形態ではウエットエッチングにより形成したが、ドライエッチングや機械加工など、他の手法で形成することもできる。また、第５の実施の形態の溝の形状は、該形状に限定する必要はなく、他の形状であっても良い。また、第５の実施形態では、一方の基板のみに溝を構成したが、他方の基板側にも同様に溝を構成することも可能である。溝を構成する基板の数は限定されず、複数枚重ねて溝を構成することも可能である。溝の深さまたは幅は電圧を印加した際に電気浸透流が発生する範囲、具体的には１５０μｍ以下であることが望ましい。請求項５中の「分離する試料を該分離素子に注入する注入用流路部」は、第５の実施の形態では試料注入口から試料排出口を結ぶ流路が該当する。請求項５中の「該試料を分離する分離カラム部」は、第５の実施の形態では支持液注入口から支持液排出口を結ぶ流路が該当する。請求項５中の「溝加工した基板流路内面のゼータ電位」は、この第５の実施の形態では、例えばホウケイ酸ガラス基板表面のゼータ電位が該当する。請求項５中の「絶縁性の無機材料」は、この第５の実施の形態では、二酸化けい素ガラスによってコートされた流路内壁が該当するが、絶縁性の無機材料であれば他の無機皮膜材料に変更が可能である。例えば、他のガラス材料、窒化シリコン、アルミナ、ダイヤモンド、五酸化タンタル等に変更することができる。また、二酸化けい素ガラスのコートはスパックリングによって行ったが、他の成膜方法、例えば、ケミカルヴエーパーデポジッション法や真空蒸着法などを用いることもできる。

【００３３】請求項５の場合にあっては、本発明に従う電気泳動素子の作用、効果は、以下のように説明することができる。本発明の電気泳動素子は、試料導入部となる注入用流路部と分離カラムとして働く表面コートされた流路との流路内壁のゼータ電位が異なる。注入用流路部の内壁はホウケイ酸ガラス表面であり、ゼータ電位の符号は表面の荷電状態から負となる。一方、分離カラムとして働く表面コートされた流路の内壁は二酸化けい素ガラスにて覆われているため、ゼータ電位の絶対値はホウケイ酸ガラス表面に比べ小さくなる。

【００３４】ところで、前記（１）式から、電圧を印加した際の電気浸透流の速さは、ゼータ電位の絶対値が大きいほど速い。つまり、本発明の電気泳動素子の電気浸透流は試薬の注入用流路部が速く分離カラム部が遅いことになる。電気浸透流が速いと分析時間が少なくて済む反面、分離効率が悪い。表面処理により電気浸透流が抑えられると分析時間が長くなるものの分離効率が向上する。従って、本発明の電気泳動素子は、注入用流路部は電気浸透流が速いため試薬導入が短時間で済み且つカラムに入れる前に試薬の分離を防ぎ、分離カラム部のみ電気浸透流を遅くして分離効率を上げることが可能となる。つまり、本発明の電気泳動素子は分離カラム部のみのゼータ電位の絶対値を小さくすることによって、高分離・高効率化が可能な機器分析用流体流路を提供するこ

とができる。また、本発明の電気泳動素子は、表面コートされた流路内壁が無機皮膜であるため、耐久性が高く、アルカリなどによる洗浄を行っても有機被膜のように劣化しない。このため、耐久性の高い、繰り返し使用可能な電気泳動素子となる。また、本発明の電気泳動素子は半導体プロセス技術を応用して作成することが可能であるため、微細な流路の小型化が可能な機器分析用流体流路を提供することができる。

【００３５】本発明はまた、請求項５記載の電気泳動素子において、該絶縁性の無機材料が、石英硝子やホウケイ酸硝子などの硝子材料、または窒化シリコン、五酸化タンタル、アルミナ、ダイヤモンドからなる構成として、好適に実施でき（第５変形例）、同様にして、上記請求項５による場合と同様の作用効果を得ることができる。

【００３６】

【発明の実施の形態】以下、本発明の実施の形態を図面に基づき説明する。図１～図３は、本発明の電気泳動素子の第１の実施の形態を示す。図１は、この第１の実施の形態における電気泳動素子の斜視図、図２は、同第１実施形態の電気泳動素子における溝加工した基板を溝加工面から見た図、図３は、同第１実施形態の電気泳動素子の作製方法の一例の説明に供する図である。

【００３７】〔第１の実施の形態の構成〕図中、１は電気泳動素子を示し、この電気泳動素子１は、例えば、ホウケイ酸ガラス基板２と溝加工したホウケイ酸ガラス基板３とを接合して構成されている。基板２と溝（図３中、参照符号１４）を有する基板３とによって囲まれた空間によって、流路４が形成されている。流路４は、ここでは、６個の枝別れを有する流路であって、支持液注入口５、支持液排出口６、試料注入口７、試料排出口８、及び２個の表面処理用試薬導入口９を構成する。

【００３８】各口にはチューブとのコネクター（図３中（ｇ），（ｈ）参照）が設けられており、ここでは、支持液注入口５、支持液排出口６、試料注入口７、及び試料排出口８の４個所には管状の白金から成る電極１０が接続されている。また、試料注入口７から試料排出口８を結ぶ注入用流路部と支持液注入口５から支持液排出口６を結ぶ分離カラム部は、交差部１１にて交差している。また、支持液注入口５から支持液排出口６を結ぶ分離カラム部は、交差部１１と支持液排出口６の間で蛇行した形状を有する。２個の表面処理用試薬導入口９は、交差部１１と支持液排出口６の間の分岐部に構成されている。

【００３９】図２は、溝加工した上記基板３を溝加工面から見た図であり、流路４の２個の表面処理用試薬導入口９は、参照符号９ａ，９ｂを付した導入口から成る。導入口９ａ～９ｂの間の流路は、トリメチルクロロシランによって表面処理された流路１２を有する。この流路１２の部分が主に分離カラムとして働く。

【００４０】ここに、電気泳動素子１の作製方法を図３を参照にしながら説明する。まず、図３（ａ）に示すように、光学研磨した平板のホウケイ酸ガラス基板３を用意する。次に、図３（ｂ）に示すように、ホウケイ酸ガラス基板３の表面にフォトレジストをスピンコートし、レジスト薄膜１３，１３を成膜する。次に、図３（ｃ）に示すように、フォトリソグラフィー技術によってレジスト薄膜１３をパターニングする。次に、図３（ｄ）に示すように、フッ酸とフッ化アンモニウムを混合した溶液に基板を浸積し、パターニングしたレジスト薄膜１３をマスクとしてホウケイ酸ガラス基板３をウェットエッチングし、溝１４を有するホウケイ酸ガラス基板３とする。溝１４は、溝の深さが１５０μｍ以下であることが望ましい。次に、図３（ｅ）に示すように、プラズマアッシャーを用いてエッチングマスクとして利用したレジスト薄膜１３を除去する。次に、図３（ｆ）に示すように、溝加工したホウケイ酸ガラス基板３と穴（２ａ）あけ加工済みのホウケイ酸ガラス基板２を重ね、ヒーター１５にて加熱して熱溶着法にて接合する。加熱温度は５００～８００℃が望ましい。次に、図３（ｇ）に示すように、接着剤にてコネクター１６を接合する。次に、図３（ｈ）に示すように、チューブ１７を介して管状の白金から成る電極１０を接続し、電気泳動素子１を完成した。

【００４１】次に，表面処理方法について説明する。電気泳動素子１の支持液注入口５、支持液排出口６、試料注入口７、及び試料排出口８をすべて密閉する。次に、表面処理用試薬導入口９ｂにベリスターポンプを接続し、吸引によって表面処理用試薬導入口９ａから１０％トリメチルクロロシランのジクロロメタン溶液を注入させる。注入後約１０分間放置することにより、表面処理された流路１２得た。

【００４２】次に，電気泳動素子１を用いた分離実験について説明する。まず、４個の電極１０に高圧電源を接続する。支持液注入口５と試料注入口７の電極１０には陽極を、支持液排出口６と試料排出口８の電極１０には陰極を接続する。流路４には予め全体に泳動バッファーを満たしておく。次に、試料注入口７に分離するための試料を注入する。試料注入口７、及び試料排出口８の間に電圧を印加し、電気浸透流によって試料注入口７から試料排出口８に向かって試料を導入する。次に、支持液注入口５と支持液排出口６の間に電圧を印加し、交差部１１に存在する試料を電気浸透流によって支持液排出口６に向かって泳動させる。泳動試料は、途中に表面処理された流路１２を有する流路を経て分離しながら支持液排出口６に向かって泳動する。

【００４３】〔第１の実施の形態の作用・効果〕次に、この第１の実施の形態の作用及び効果を説明する。キャピラリー電気泳動においてはキャピラリーに支持液として電解質溶液を満たして分析を行うが、このことにより

キャピラリー内壁及びこれと接する電解質溶液の間に電気二重層が形成される。ここに、電圧が印加されると電解質溶液が溶媒を伴って移動し、電気浸透流が生じる。電気凌透流は分離された成分イオンを移動させる駆動力として利用することができる。電気浸透流速υは電解質溶液の誘電率εと粘性率η、ゼータ電位ξおよびキャピラリーに沿ってかけられる電場の強さＥの関係として下記式で表される。ゼータ電位とはキャピラリー内壁と電解質溶液管の電位差のことである。

【数２】$\upsilon = -(\varepsilon\xi/\eta)E$　　・・・・（１）

【００４４】ゼータ電位ξはキャピラリー内壁の荷電状態において正負いずれの符号をもとりうるが、通常用キャピラリーに用いられるガラス表面では負になるため、υは正となり、従って電気浸透流は陽極から陰極へ向かう。

【００４５】ここに、本実施の形態に従う電気泳動素子１は、試料注入口７から試料排出口８を結ぶ注入用流路部と支持液注入口５から支持液排出口６を結ぶ分離カラム部は、交差部１１にて交差しているとともに、分離カラム部内面の少なくとも一部分が、注入用流路部内面のゼータ電位とは異なるゼータ電位の表面を有している。

【００４６】すなわち、上記電気泳動素子１は、試料導入部となる試料注入口７から試料排出口８を結ぶ注入用流路部と分離カラムとして働く表面処理された流路１２との流路内壁のゼータ電位が異なる。試料注入口７から試料排出口８を結ぶ流路の内壁はホウケイ酸ガラス表面であり、ゼータ電位の符号は表面の荷電状態から負となる。一方、分離カラムとして働く表面処理された流路１２の内壁は非イオン性の表面処理剤にて覆われているため表面の荷電は弱くなり、ゼータ電位の絶対値は表面未処理の流路内壁に比べ小さくなる。

【００４７】（１）式から、電圧を印加した際の電気浸透流の速さは、ゼータ電位の絶対値が大きいほど速い。つまり、上記電気泳動素子１の電気浸透流は試薬の注入用流路部が速く分離カラム部が遅いことになる。電気浸透流が速いと分析時間が少なくて済む反面、分離効率が悪い。表面処理により電気浸透流が抑えられると分析時間が長くなるものの分離効率が向上する。従って、上記電気泳動素子１は、注入用流路部は電気浸透流が速いため試薬導入が短時間で済み且つカラムに入れる前に試薬の分離を防ぎ、分離カラム部のみ電気浸透流を遅くして分離効率を上げることが可能となる。つまり、電気泳動素子１は分離カラム部のみのゼータ電位の絶対値を小さくすることによって、高分離・高効率化が可能な機器分析用流体流路を提供することができる。また、上記作成方法（図３）に記載したように、電気泳動素子１は半導体プロセス技術を応用して作成することが可能であるため、微細な流路の小型化が可能な機器分析用流体流路を提供することができる。かくして、本実施の形態の構成に従えば、高分離・高効率化が可能であって、且つ小型化が可能な機器分析用電気泳動素子が実現される。

【００４８】〔第１の実施の形態の変形、変更〕なお、この第１の実施の形態の各構成は、当然、各種変形、変更が可能である。

〔１－１〕例えば、ホウケイ酸ガラス基板２とホウケイ酸ガラス基板３は、他の素材のガラス基板やシリコンウェハへの変更が可能である。また、プラスチック基板への変更も可能である。

〔１－２〕基板２と溝を有する基板３とによって囲まれた空間によって構成された流路４は、基板２が溝を有する構成に変更することも可能であり、基板２，３共に溝を有する構成にすることも可能である。

【００４９】〔１－３〕２個の表面処理用試薬導入口９は、２個以上であればその数に限定されず、複数の表面処理用試薬導入口を構成して複数の表面処理剤にて部分的な表面処理をすることも可能である。

〔１－４〕また、支持液注入口５から支持液排出口６を結ぶ分離カラム部は、交差部１１と支持液排出口６の間で蛇行した形状を有するが、形状は限定されず、直線形状等への変更が可能である。

〔１－５〕白金から成る電極１０の素材は白金に限定されず、金等の他の導電性物質に変更が可能である。また、電極が接続されている部位は、支持液注入口５、支持液排出口６、試料注入口７、及び試料排出口８の４個所に限定されず、２個の表面処理用試薬導入口９に接続して電圧印加ポイントを可変することも可能である。

【００５０】〔１－６〕また、接続された電極の正負は特に限定されず、目的に応じて可変することも可能である。例えば、ゼータ電位の値の符号が正の表面の場合は、電気浸透流は正極に流れるため、接続する電極の正負は本実施形態と反対にすることで同様な泳動が可能となる。

〔１－７〕表面処理に用いたトリメチルクロロシランは、他の一般的表面処理剤に変更することができる。例えば、他のシランカップリング剤に変更することができる。また、カルボキシメチルセルロースやポリアクリルアミドなどの親水性高分子や界面活性剤等に変更することもできる。これらの点は、以下の例における変形、変更の場合にも準ずる。

【００５１】〔第２の実施の形態の構成〕次に、本発明の電気泳動素子の第２の実施の形態を示す。本実施形態は、試料を分離する分離カラム部と、分離した試料を分取する分取用流路部とが交差して成る電気泳動素子であって、分離カラム部内面の少なくとも一部分が、分取用流路内面のゼータ電位とは異なるゼータ電位の表面を有するようにしようというものである。本実施の形態は、前記第１の実施の形態の変形例とも捉えることもできる。図４は、この第２の実施の形態における電気泳動素子２０の斜視図、図５は、その電気泳動素子２０における溝加工した基板を溝加工面から見た図である。

【００５２】基本的な構成は第１実施形態で例示したのと同様であってよく、この電気泳動素子２０は、ホウケイ酸ガラス基板２１と溝加工したホウケイ酸ガラス基板２２とを接合して構成されている。基板２１と溝を有する基板２２とによって囲まれた空間によって、流路２３が形成されている。

【００５３】流路２３は、ここでは、８個の枝別れを有する流路であって、支持液注入口５、支持液排出口６、試料注入口７、試料排出口８、２個の試料分取口２４（２４ａ，２４ｂ）、及び２個の表面処理用試薬導入口９を構成する。各口にはチューブとのコネクターが設けられており、支持液注入口５、支持液排出口６、試料注入口７、試料排出口８及び試料分取口２４には管状の白金から成る電極１０が接続されている。また、試料注入口７から試料排出口８を結ぶ注入用流路部と支持液注入口５から支持液排出口６を結ぶ分離カラム部は、交差部１１にて交差している。また、支持液注入口５から支持液排出口６を結ぶ分離カラム部と分取口２４ａから分取口２４ｂを結ぶ分取用流路部は、交差部２５にて交差している。また、支持液注入口５から支持液排出口６を結ぶ分離カラム部は、交差部１１と交差部２５の間で蛇行した形状を有する。２個の表面処理用試薬導入口９は、交差部１１と交差部２５の間の分岐部に構成されている。

【００５４】図５は、溝加工した上記基板２２を溝加工面から見た図であり、流路２３の２個の表面処理用試薬導入口９は、導入口９ａ，９ｂから成る。導入口９ａ～９ｂの間の流路はトリメチルクロロシランによって表面処理された流路内壁１２を有する。この流路内壁１２の部分が主に分離カラムとして働く。

【００５５】この電気泳動素子２０の作製方法は、第１実施形態に示した電気泳動素子１の作製方法（図３）と同様であり、フォトリソグラーフィーに用いるマスクパターンを電気泳動素子２０用に設計して作製を行う。

【００５６】表面処理方法は、第１実施形態に示した電気泳動素子１の表面処理方法と同様である。つまり、電気泳動素子２０の支持液注入口５、支持液排出口６、試料注入口７、試料排出口８、及び２個の試料分取口２４をすべて密閉する。次に、表面処理用試薬導入口９ｂにベリスターポンプを接続し、吸引によって表面処理用試薬導入口９ａから１０％トリメチルクロロシランのジクロロメタン溶液を注入させる。注入後約１０分間放置することにより、表面処理された流路１２を得た。

【００５７】次に、この電気泳動素子２０を用いた分離・分取実験について説明する。まず、６個の電極１０に高圧電源を接続する。支持液注入口５、試料注入口７、分取口２４ａの電極には陽極を、支持液排出口６、試料排出口８、分取口２４ｂの電極には陰極を接続する。流路２３には予め全体に泳動バッファーを満たしておく。次に、試料注入口７に分離するための試料を注入する。試料注入口７、及び試料排出口８の間に電圧を印加し、電気浸透流によって試料注入口７から試料排出口８に向かって試料を導入する。次に、支持液注入口５と支持液排出口６の間に電圧を印加し、交差部１１に存在する試料を電気浸透流によって支持液排出口６に向かって泳動させる。泳動試料は、途中に表面処理された流路１２を有する流路を経て分離しながら支持液排出口６に向かって泳動する。

【００５８】ここで、交差部２５または交差部２５の支持液注入口５側にて、図示しない分離物質の検出系を用い分離状態を検出する。分取目的の分離物質が交差部２５を通過する際、分取口２４ａと分取口２４ｂの間に電圧を印加し、該分離物質のみを分取口２４ｂに向かって泳動させ分取する。

【００５９】〔第２の実施の形態の作用・効果〕次に、この第２の実施の形態の作用及び効果を説明する。本実施の形態に従う電気泳動素子２０は、第１実施形態と同様の作用・効果を奏すると共に、これに加えて、下記作用・効果を有する。

【００６０】上記電気泳動素子２０は、分離カラムとして働く表面処理された流路１２と、分離物質の分取に用いる分取口２４ａから分取口２４ｂを結ぶ分取用流路部との流路内壁のゼータ電位が異なる。分取口２４ａから分取口２４ｂを結ぶ流路の内壁はホウケイ酸ガラス表面であり、ゼータ電位の符号は表面の荷電状態から負となる。一方、分離カラムとして働く表面処理された流路１２の内壁は非イオン性の表面処理剤にて覆われているため表面の荷電は弱くなり、ゼータ電位の絶対値は表面未処理の流路内壁に比べ小さくなる。

【００６１】ここで、第１実施形態記載の（１）式から、電圧を印加した際の電気浸透流の速さは、ゼータ電位の絶対値が大きいほど速い。つまり、上記電気泳動素子２０の電気浸透流は分取用流路部が速く分離カラム部が遅いことになる。電気浸透流が速いと分析時間が少なくて済む反面、分離効率が悪い。表面処理により電気浸透流が抑えられると分析時間が長くなるものの分離効率が向上する。従って、上記電気泳動素子２０は、分離カラム部のみ電気浸透流を遅くして分離効率を上げ、分取用流路部は電気浸透流が速いため分取を短時間で行うことができ、且つ分取前に試薬の分離を防ぐことが可能となる。

【００６２】つまり、電気泳動素子２０は分離カラム部のみのゼータ電位の絶対値を小さくすることによって、高分離・高効率化が可能な機器分析用流体流路を提供することができる。また、上記作成方法に記載したように、第１実施形態の場合と同様、電気泳動素子２０は半導体プロセス技術を応用して作成することが可能であるため、微細な流路の小型化が可能な機器分析用流体流路を提供することができる。本発明は、このようにして実施することもできる。

【００６３】〔第２の実施の形態の変形、変更〕なお、この第２の実施の形態の各構成も、第１実施形態と同様、当然、各種変形、変更（〔第１の実施の形態の変形、変更〕を含む）が可能である。

【００６４】〔２－１〕特に、図６に４個の表面処理用試薬導入口を構成した場合の変更例である電気泳動素子３０を示す。この電気泳動素子３０は、ホウケイ酸ガラス基板３１と溝加工したホウケイ酸ガラス基板３２とを接合して構成されている。電気泳動素子３０は、４個の表面処理用試薬導入口９（９ａ，９ｂ，９ｃ，９ｄ）を有している。これら４個の表面処理用試薬導入口９は、交差部１１と交差部２５の間の分岐部に構成されている。図７は、溝加工した上記基板３２を溝加工表面から見た図である。流路３３は、表面処理用試薬導入口９ａと９ｂから表面処理剤を注入・排出して処理した流路内壁３４と、表面処理用試薬導入口９ｃと９ｄから表面処理剤を注入・排出して処理した流路内壁３５とを有する。このように、表面処理用試薬導入口９を多数設けることによって、多種の表面処理が可能となる。本発明は、このようにして実施してもよい。

【００６５】〔第３の実施の形態の構成〕次に、本発明の電気泳動素子の第３の実施の形態を示す。本実施形態は、分取用流路部を複数有する電気泳動素子であって、少なくとも一つの分取用流路部が分離カラム部の任意の位置に構成され、該分取用流路部を境に両端の分離カラム部内面の少なくとも一部分のゼータ電位が、該分取用流路内面のゼータ電位とは異なるゼータ電位の表面を有するようにしようというものである。本実施の形態は、前記第１の実施の形態の変形例と捉えることもできるものであり、前記第２の実施の形態（第２の実施の形態の変形、変更の例を含む）の変形例と捉えることもできる。図８は、この第３の実施の形態における電気泳動素子４０の斜視図、図９は、その電気泳動素子４０における溝加工した基板を溝加工面から見た図である。

【００６６】基本的な構成は第１、第２実施形態で例示したのと同様であってよく、この電気泳動素子４０は、ホウケイ酸ガラス基板４１と溝加工したホウケイ酸ガラス基板４２とを接合して構成されている。基板４１と溝を有する基板４２とによって囲まれた空間によって、流路４３が形成されている。

【００６７】流路４３は、ここでは、１２個の枝別れを有する流路であって、支持液注入口５、支持液排出口６、試料注入口７、試料排出口８、２個で１対の試料分取口２４（２４ａ，２４ｂ）と４４（４４ａ，４４ｂ）、及び４個の表面処理用試薬導入口９を構成する。各口にはチューブとのコネクターが設けられており、支持液注入口５、支持液排出口６、試料注入口７、試料排出口 8、試料分取口２４び試料分取口４４には管状の白金から成る電極１０が接続されている。

【００６８】また、試料注入口 7から試料排出口８を結ぶ注入用流路部と支持液注入口５から支持液排出口６を結ぶ分離カラム部は、交差部１１にて交差している。また、支持液注入口５から支持液梯出口６を結ぶ分離カラム部と分取口２４ａから分取口２４ｂを結ぶ分取用流路部は、交差部２５にて交差している。また、支持液注入口５から支持液排出口６を結ぶ分離カラム部と分取口４４ａから分取口４４ｂを結ぶ分取用流路部は、分離カラム部の中央に位置する交差部４５にて交差している。また、支持液注入口５から支持液排出口６を結ぶ分離カラム部は、交差部１１と交差部４５の間、及び交差部４５と交差部２５の間で蛇行した形状を有する。４個の表面処理用試薬導入口９は、交差部１１と交差部４５の間の分岐部に２個、交差部４５と交差部２５の間に２個構成されている。

【００６９】図９は，溝加工した上記基板４２を溝加工面から見た図である。流路４３の４個の表面処理用試薬導入口９は、導入口９ａ～９ｄの各導入口から成る。導入口９ａ～９ｂの間の流路はトリメチルクロロシランによって表面処理された流路内壁４６を、導入口９ｃ～９ｄの間の流路はトリメチルクロロシランによって表面処理された流路内壁４７を有する。この流路内壁４６，４７の部分が主に分離カラムとして働く。

【００７０】この電気泳動素子４０の作製方法は、第１実施形態に示した電気泳動素子１の作製方法（図３）と同様であり、フォトリソグラーフィーに用いるマスクパターンを電気泳動素子４０用に設計して作製を行う。

【００７１】表面処理方法は、第１実施形態に示した電気泳動素子１の表面処理方法と同様である。つまり、まず、表面処理用試薬導入口９ａと９ｂ以外の液の出入口をすべて密閉する。次に、表面処理用試薬導入口９ｂにペリスターポンプを接続し、吸引によって表面処理用試薬導入口９ａから１０％トリメチルクロロシランのジクロロメタン溶液を注入させる。注入後約１０分間放置することにより、表面処理された流路４６を得た。次に、表面処理用試薬導入口９ｃと９ｄ以外の液の出入口をすべて密閉する。次に、表面処理用試薬専入口９ｄにペリスターポンプを接続し、吸引によって表面処理用試薬導入口９ｃから１０％トリメチルクロロシランのジクロロメタン溶液を注入させる。注入後約１０分間放置することにより、表面処理された流路４７を得た。

【００７２】次に、この電気泳動素子４０を用いた分離・分取実験について説明する。まず、８個の電極１０に高圧電源を接続する。支持液注入口５、試料注入口７、分取口２４ａ、分取口４４ａの電極には陽極を、支持液排出口６、試料排出口８、分取口２４ｂ、分取口４４ｂの電極には陰極を接続する。流路４３には予め全体に泳動バッファーを満たしておく。

【００７３】次に、試料注入口７に分離するための試料を注入する。試料注入口７、及び試料排出口８の間に電圧を印加し、電気浸透流によって試料注入口７から試料

排出口８に向かって試料を導入する。次に、支持液注入口５と支持液排出口６の間に電圧を印加し、交差部１１に存在する試料を電気浸透流によって支持液排出口６に向かって泳動させる。泳動試料は、途中に表面処理された流路４６を有する流路を経て分離しながら支持液排出口６に向かって泳動する。

【００７４】ここで、交差部４５または交差部４５の支持液注入口５側にて、図示しない分離物質の検出系を用い分離状態を検出する。この検出点にて目的とする分離が生じていた場合、分取目的の分離物質が交差部４５を通過する際、分取口４４ａと分取口４４ｂの間に電圧を印加し、該分離物質のみを分取口２４ｂに向かって泳動させ分取する。交差部４５の検出点にて目的とする分離が不十分だった場合、支持液注入口５と支持液排出口６の間への電圧印加を続ける。泳動試料は、途中に表面処理された流路４７を有する流路を経て分離しながら支持液排出口６に向かって泳動する。

【００７５】さらに、交差部２５または交差部２５の支持液注入口５側にて、図示しない分離物質の検出系を用い分離状態を検出する。分取目的の分離物質が交差部２５を通過する際、分取口２４ａと分取口２４ｂの間に電圧を印加し、該分離物質のみを分取口２４ｂに向かって泳動させ分取する。

【００７６】〔第３の実施の形態の作用・効果〕次に、この第３の実施の形態の作用及び効果を説明する。本実施の形態に従う電気泳動素子４０は、第１及び第２実施形態と同様の作用・効果を奏すると共に、これに加えて、下記作用・効果を有する。

【００７７】上記電気泳動素子４０は、分離カラムとして働く表面処理された２つの流路４６と４７を有し、流路４６と４７の間に分離物質の分取に用いる分取口４４ａから分取口４４ｂを結ぶ分取用流路部が構成され、さらに分離物質の泳動末端となる支持液排出口６側に分離物質の分取に用いる分取口２４ａから分取口２４ｂを結ぶ分取用流路部が構成されている。２つの分取用流路部の内壁はホウケイ酸ガラス表面であり、ゼータ電位の符号は表面の荷電状態から負となる。表面処理された流路４６と４７の内壁は非イオン性の表面処理剤にて覆われているため表面の荷電は弱くなり、ゼータ電位の絶対値は表面未処理の流路内壁に比べ小さくなる。流路４６と流路４７は、同一の表面処理剤によって処理されており、流路内壁のゼータ電位は等しい。

【００７８】ここで、第１実施形態記載の（１）式から、電圧を印加した際の電気浸透流の速さは、ゼータ電位の絶対値が大きいほど速い。つまり、上記電気泳動素子４０の電気浸透流は２つの分取用流路部が速く２つの分離カラム部が遅いことになる。電気浸透流が速いと分析時間が少なくて済む反面、分離効率が悪い。表面処理により電気浸透流が抑えられると分析時間が長くなるものの分離効率が向上する。流路４６にて目的の分離が生じた場合は、その時点で分取口４４ａから分取口４４ｂを結ぶ分取用流路部にて分取目的の分離物質を分取できるため、分離から分取までが速くなる。また、流路４６では分離不十分だった場合は、さらに流路４７にて分離させ分取口２４ａから分取口２４ｂを結ぶ分取用流路部から分取目的の分離物質を分取できる。このように、電気泳動素子４０は試料の分離過程において、分離に応じて分取することが可能となり、効率良く分離・分取を進めることができる。

【００７９】つまり、電気泳動素子４０はゼータ電位の絶対値の小さい２つの分離カラム部の間と泳動末端部にゼータ電位の絶対値の大きい分取用流路部を設けることによって、高分離・高効率化が可能な機器分析用流体流路を提供することができる。また、上記作成方法に記載したように、第１実施形態の場合と同様、電気泳動素子４０は半導体プロセス技術を応用して作成することが可能であるため、微細な流路の小型化が可能な機器分析用流体流路を提供することができる。本発明は、このようにして実施することもできる。

【００８０】〔第３の実施の形態の変形、変更〕なお、この第３の実施の形態の各構成は、第１、第２実施形態と同様、当然、各種変形、変更（〔第１の実施の形態の変形、変更〕を含み、〔第２の実施の形態の変形、変更〕を含む）が可能である。

【００８１】〔３－１〕例えば、支持液注入口５から支持液排出口６を結ぶ分離カラム部と分取口４４ａから分取口４４ｂを結ぶ分取用流路部は、分離カラム部の中央に位置する交差部４５にて交差しているが、該交差部の位置は限定されず任意の位置に構成することができる。

〔３－２〕また、支持液注入口５から支持液排出口６を結ぶ分離カラム部の任意の位置に構成された分取用流路部の数も限定されない。

〔３－３〕また、該分取用流路部にて分割された分離カラム部はそれぞれが異なる表面処理を施し異なるゼータ電位とすることが可能であり、また同じ表面処理を施すことも可能である。

〔３－４〕さらに、後記図１４，１５に示すような変形も可能である。本発明は、このようにして実施してもよい。

【００８２】〔第４の実施の形態の構成〕次に、本発明の電気泳動素子の第４の実施の形態を示す。本実施形態は、分取用流路部を複数有すると共に、複数の分取用流路部に挟まれた分離カラム部の注入用流路部側に電圧印加用流路部を設けというものである。本実施の形態は、前記第１の実施の形態の変形例と捉えることもできるものであり、また前記第２の実施の形態（第２の実施の形態の変形、変更の例を含む）の変形例と捉えることもできるものであり、前記第３の実施の形態（第３の実施の形態の変形、変更の例を含む）の変形例と捉えることもできる。図１０は、この第４の実施の形態における電気

泳動素子５０の斜視図、図１１は、その電気泳動素子５０における溝加工した基板を溝加工面から見た図である。

【００８３】基本的な構成は第１、第２、第３実施形態で例示したのと同様であってよく、この電気泳動素子５０は、ホウケイ酸ガラス基板５１と溝加工したホウケイ酸ガラス基板５２とを接合して構成されている。基板５１と溝を有する基板５２とによって囲まれた空間によって、流路５３が形成されている。

【００８４】流路５３は、ここでは、１３個の枝別れを有する流路であって、支持液注入口５、支持液排出口６、試料注入口７、試料排出口８、２個で１対の試料分取口２４（２４ａ，２４ｂ）と４４（４４ａ，４４ｂ）、４個の表面処理用試薬導入口９、及び電圧印加用流路口５４を構成する。各口にはチューブとのコネクターが設けられており、支持液注入口５、支持液排出口６、試料注入口７、試料排出口８、試料分取口２４、試料分取口４４及び電圧印加用流路口５４には管状の白金から成る電極１０が接続されている。電圧印加用流路口５４は、電圧印加ポイントを切り換えるのに用いることができる。

【００８５】また、試料注入口７から試料排出口８を結ぶ注入用流路部と支持液注入口５から支持液排出口６を結ぶ分離カラム部は、交差部１１にて交差している。また、支持液注入口５から支持液排出口６を結ぶ分離カラム部と分取口２４ａから分取口２４ｂを結ぶ分取用流路部は、交差部２５にて交差している。また、支持液注入口５から支持液排出口６を結ぶ分離カラム部と分取口４４ａから分取口４４ｂを結ぶ分取用流路部は、分離カラム部のほぼ中央に位置する交差部４５にて交差している。また、支持液注入口５から支持液排出口６を結ぶ分離カラム部は、交差部１１と交差部４５の間、及び交差部４５と交差部２５の間で蛇行した形状を有する。４個の表面処理用試薬導入口９は、交差部１１と交差部４５の間の分岐部に２個、交差部４５と交差部２５間に２個構成されている。

【００８６】図１１は、溝加工した上記基板５２を溝加工面から見た図である。流路５３の４個の表面処理用試薬導入口９は、導入口９ａ～９ｄの各導入口から成る。導入口９ａ～９ｂの間の流路はトリメチルクロロシランによって表面処理された流路内壁４６を、９ｃ～９ｄの間の流路はジメチルアロビルクロロシランによって表面処理された流路内壁５５を有する。この流路内壁４６、５５の部分が主に分離カラムとして働く。電圧印加用流路口５４は、交差部４５と流路内壁５５の間の分岐流路に構成されている。

【００８７】この電気泳動素子５０の作製方法は、第１実施形態に示した電気泳動素子１の作製方法（図３）と同様であり、フォトリソグラーフィーに用いるマスクパターンを電気泳動素子５０用に設計して作製を行う。

【００８８】表面処理方法は、第１実施形態に示した電気泳動素子１の表面処理方法と同様である。つまり、まず表面処理用試薬導入口９ａと９ｂ以外の液の出入口をすべて密閉する。次に、表面処理用試薬導入口９ｂにベリスターポンプを接続し、吸引によって表面処理用試薬導入口９ａから１０％トリメチルクロロシランのジクロロメタン溶液を注入させる。注入後約１０分間放置することにより、表面処理された流路４６を得た。次に、表面処理用試薬導入口９ｃと９ｄ以外の液の出入口をすべて密閉する。次に、表面処理用試薬導入口９ｄにベリスターポンプを接続し、吸引によって表面処理用試薬導入口９ｃから１０％ジメチルプロピルクロロシランのジクロロメタン溶液を注入させる。注入後約１０分間放置することにより、表面処理された流路５５を得た。

【００８９】次に、この電気泳動素子５０を用いた分離・分取実験について説明する。まず、９個の電極１０に高圧電源を接続する。支持液注入口５、試料注入口７、分取口２４ａ、分取口４４ａの電極には陽極を、支持液排出口６、支持液排出口６、試料排出口８、分取口２４ｂ、分取口４４ｂ、電圧印加用流路口５４の電極には陰極を接続する。流路５３には予め全体に泳動バッファーを満たしておく。

【００９０】次に、試料注入口７に分離するための試料を注入する。試料注入口７、及び試料排出口８の間に電圧を印加し、電気浸透流によって試料注入口７から試料排出口８に向かって試料を導入する。次に、支持液注入口５と電圧印加用流路口５４の間に電圧を印加し、交差部１１に存在する試料を電気浸透流によって電圧印加用流路口５４に向かって泳動させる。泳動試料は、途中に表面処理された流路４６を有する流路を経て分離しながら電圧印加用流路口５４に向かって泳動する。

【００９１】ここで、交差部４５または交差部４５の支持液注入口５側にて、図示しない分離物質の検出系を用い分離状態を検出する。この検出点にて目的とする分離が生じていた場合、分取目的の分離物質が交差部４５を通過する際、分取口４４ａと分取口４４ｂの間に電圧を印加し、該分離物質のみを分取口２４ｂに向かって泳動させ分取する。交差部４５の検出点にて目的とする分離が不十分だった場合、試料が交差部４５を通過した直後に、分取口４４ａと支持液排出口６の間に電圧を印加する。泳動試料は、途中に表面処理された流路５５を有する流路を経て分離しながら支持液排出口６に向かって泳動する。

【００９２】さらに、交差部２５または交差部２５の支持液注入口５側にて、図示しない分離物質の検出系を用い分離状態を検出する。分取目的の分離物質が交差部２５を通過する際、分取口２４ａと分取口２４ｂの間に電圧を印加し、該分離物質のみを分取口２４ｂに向かって泳動させ分取する。

【００９３】〔第４の実施の形態の作用、効果〕次に、

この第４の実施の形態の作用及び効果を説明する。本実施形態に従う電気泳動素子５０は、第１、第２、第３実施形態と同様の作用・効果を奏すると共に、これに加えて、下記作用・効果を有する。上記電気泳動素子５０は、分離カラムとして働く表面処理された２つの流路４６と５５を有し、流路４６と５５の間に分離物質の分取に用いる分取口４４ａから分取口４４ｂを結ぶ分取用流路部と電圧印加ポイントを切り換えるために用いる電圧印加用流路口５４が構成され、さらに分離物質の泳動末端となる支持液排出口６側に分離物質の分取に用いる分取口２４ａから分取口２４ｂを結ぶ分取用流路部が構成されている。流路４６、流路５５及び２つの分取用流路部は、流路内壁のゼータ電位が異なる。２つの分取用流路部の内壁はホウケイ酸ガラス表面であり、ゼータ電位の符号は表面の荷電状態から負となる。表面処理された流路４６と５５の内壁は非イオン性の表面処理剤にて覆われているため表面の荷電は弱くなり、ゼータ電位の絶対値は表面未処理の流路内壁に比べ小さくなる。また、流路４６と流路５５とは異なる表面処理剤で覆われているため、流路内壁のゼータ電位が異なる。流路５５は流路４６よりも疎水性の強い表面処理剤で覆われているため、表面の電荷は弱くなり、ゼータ電位の絶対値は流路４６に比べさらに小さくなる。

【００９４】ここで、第１実施形態記載の（１）式から、電圧を印加した際の電気浸透流の速さは、ゼータ電位の絶対値が大きいほど速い。つまり、上記電気泳動素子５０の電気浸透流は流路５５が最も遅く、流路４６、２つの分取用流路部の順で速くなる。電気浸透流が速いと分析時間が少なくて済む反面、分離効率が悪い。表面処理により電気浸透流が抑えられると分析時間が長くなるものの分離効率が向上する。従って、流路４６は流路５５に比べ分離効率は劣るものの分析時間は短い。流路４６にて目的の分離が生じた場合は、その時点で分取口４４ａから分取口４４ｂを結ぶ分取用流路部にて分取目的の分離物質を分取できるため、分離から分取までが速くなる。また、流路４６では分離不十分だった場合は、さらに分離効率の高い流路５５にて分離させ分取口２４ａから分取口２４ｂを結ぶ分取用流路部から分取目的の分離物質を分取できる。また、流路４６と流路５５への電圧印加ポイントを切り換えて電圧印可することにより、表面処理の効果を反映した電気浸透流を実現することができる。

【００９５】つまり、電気泳動素子５０は、上記作用・効果に説明したように、高分離・高効率化が可能な機器分析用流体流路を提供することができる。また、上記作成方法に記載したように、電気泳動素子５０は半導体プロセス技術を応用して作成することが可能であるため、微細な流路の小型化が可能な機器分析用流体流路を提供することができる。高分離・高効率化が可能で、且つ小型化が可能な機器分析用電気泳動素子を実現せしめる本発明は、このようにして実施することができる。

【００９６】〔第４の実施の形態の変形、変更〕なお、この第４の実施の形態の各構成は、第１、第２、第３実施形態と同様、当然、各種変形、変更（〔第１の実施の形態の変形、変更〕を含み、〔第２の実施の形態の変形、変更〕を含み、〔第２の実施の形態の変形、変更〕を含む）が可能である。

〔４－１〕従って、例えば、後記図１６，１７に示すような変形も可能である。本発明は、このようにして実施してもよい。

【００９７】〔第５の実施の形態の構成〕次に、本発明の電気泳動素子の第５の実施の形態を示す。本実施形態は、溝加工した平板を複数重ねて液流路を構成した電気泳動素子において、少なくとも該電気泳動素子にて分離する試料を該分離素子に注入する注入用流路部と、該試料を分離する分離カラム部とが交差して成る電気泳動素子であって、該分離カラム部内面の少なくとも一部分が、溝加工した基板流路内面のゼータ電位とは異なるゼータ電位の表面を有していて、さらに、その溝加工した基板のゼータ電位とは異なるゼータ電位の表面が、絶縁性の無機材料によって構成されるようにしようというものである。本実施の形態は、例えば、前記第１の実施の形態の変形例と捉えることもできるものであり、また、前記第２の実施の形態（第２の実施の形態の変形、変更の例を含む）の変形例と捉えることもできる。図１２は、この第４の実施の形態に従った電気泳動素子６０の断面図、図１３は、その電気泳動素子６０における溝加工した基板を溝加工面から見た図である。

【００９８】以下、図示した例に基づいて説明すると、この電気泳動素子６９は、ここでは、第２実施形態に示した電気泳動素子２０とその構造は類似し、電気泳動素子２０における表面処理用試薬導入口９を持たない構成となっている。同様にまた、電気泳動素子６０は、ホウケイ酸ガラス基板６１と溝加工したホウケイ酸ガラス基板６２とを接合して構成されている。基板６１と溝を有する基板６２とによって囲まれた空間によって、流路６３が形成されている。

【００９９】流路６３は、ここでは、６個の枝別れを有する流路であって、支持液注入口５、支持液排出口６、試料注入口７、試料排出口８、及び２個の試料分取口２４（２４ａ，２４ｂ）を構成する。各口にはチューブとのコネクターが設けられており、管状の白金から成る電極１０が接続されている。また、試料注入口７から試料排出口８を結ぶ注入用流路部と支持液注入口５から支持液排出口６を結ぶ分離カラム部は、交差部１１にて交差している。また、支持液注入口５から支持液排出口６を結ぶ分離カラム部と分取口２４ａから分取口２４ｂを結ぶ分取用流路部は、交差部２５にて交差している。また、支持液注入口５から支持液排出口６を結ぶ分離カラム部は、交差部１１と交差部２５の間で蛇行した形状を

有する。

【０１００】図１３は，溝加工した上記基板６２を溝加工面から見た図である。流路６３は二酸化けい素ガラスによってコートされた流路内壁６４を有する。この流路内壁６４の部分が分離カラムとして働く。

【０１０１】上記電気泳動素子６０の作成方法は、一般のフォトリソグラフィー技術、エッチング技術、成膜技術を利用した。流路内壁６４の作成は、図３に示した作製方法の同図（ｄ）のウェットエッチングの後、二酸化けい素をスパッタリングによって成膜することで得られる。また、溝加工したホウケイ酸ガラス基板６２に重ねるホウケイ酸ガラス基板６１も、フォトリソグラフィー技術、エッチング技術、成膜技術を利用して、流路内壁６４を構成する部分に二酸化けい素を成膜して構成する。

【０１０２】次に、この電気泳動素子６０を用いた分離・分取実験について説明する。まず、６個の電極１０に高圧電源を接続する。支持液注入口５、試料注入口７、分取口２４ａの電極には陽極を、支持液排出口６、試料排出口８、分取口２４ｂの電極には陰極を接続する。流路６３には予め全体に泳動バッファーを満たしておく。

【０１０３】次に、試料注入口７に分離するための試料を注入する。試料注入口７、及び試料排出口８の間に電圧を印加し、電気浸透流によって試料注入口７から試料排出口８に向かって試料を導入する。次に、支持液注入口５と支持液排出口６の間に電圧を印加し、交差部１１に存在する試料を電気浸透流によって支持液排出口６に向かって泳動させる。泳動試料は、途中に表面処理された流路６４を有する流路を経て分離しながら支持液排出口６に向かって泳動する。

【０１０４】ここで、交差部２５または交差部２５の支持液注入口５側にて、図示しない分離物質の検出系を用い分離状態を検出する。分取目的の分離物質が交差部２５を通過する際、分取口２４ａと分取口２４ｂの間に電圧を印加し、該分離物質のみを分取口２４ｂに向かって泳動させ分取する。

【０１０５】〔第５の実施の形態の作用・効果〕次に、この第５の実施の形態の作用及び効果を説明する。上記電気泳動素子６０は、試料導入部となる試料注入口７から試料排出口８を結ぶ流路と分離カラム部となる表面コートされた流路６４の流路内壁のゼータ電位が異なる。また、流路６４と、分離物質の分取に用いる分取口２４ａから分取口２４ｂを結ぶ分取用流路部との流路内壁のゼータ電位が異なる。試料導入部と分取用流路部の内壁はホウケイ酸ガラス表面であり、ゼータ電位の符号は表面の荷電状態から負となる。一方、分離カラムとして働く流路６４の内壁は、ゼータ電位の符号は表面の荷電状態から負となるものの、可動イオンを持たない二酸化けい素ガラスにて覆われているため、ゼータ電位の絶対値はホウケイ酸ガラス表面に比べ小さくなる。従って、上記電気泳動素子６０は、第１、第２実施形態に示した作用・効果を有する。

【０１０６】また、上記電気泳動素子６０は、第１、第２実施形態に示した作用・効果に加え、下記作用・効果を有する。表面コートされた流路６４の内壁は無機皮膜であるため、耐久性が高く、アルカリなどによる洗浄を行っても有機被膜のように劣化しない。このため、耐久性の高い、繰り返し使用可能な電気泳動素子となる。

【０１０７】また、上記作成方法に記載したように、電気泳動素子６０は半導体プロセス技術を応用して作成することが可能であるため、微細な流路の小型化が可能な機器分析用流体流路を提供することができる。かくして、本実施の形態の構成に従えば、高分離・高効率化が可能で、且つ小型化が可能であり、さらにはまた、耐久性の高い表面修飾用内壁を有する機器分析用電気泳動素子が実現される。本発明は、このようにして実施することもできる。

【０１０８】〔第５の実施の形態の変更、変形〕なお、この第５の実施の形態の各構成は、当然、各種変形、変更（〔第１の実施の形態の変更、変形〕を含む）が可能である。

〔５－１〕また、例えば、流路６４の表面を覆っている二酸化けい素ガラスは、絶縁性の無機材料であれば他の無機皮膜材料に変更が可能である。例えば、他のガラス材料、窒化シリコン、アルミナ、ダイヤモンド、五酸化タンタル等に変更することができる。

〔５－２〕また、電気泳動素子６０は、第２実施形態に示した電気泳動素子２０における表面処理用試薬導入口９を持たない構成となっているが、第１、第３、第４実施形態に示した電気泳動素子１，３０，４０，５０における表面処理用試薬導入口９を持たない構成とすることもできる。

【０１０９】〔５－３〕例えば、図１４に第３実施形態の電気泳動素子４０の変更例である電気泳動素子７０の斜視図を示す。この電気泳動素子７０は、電気泳動素子４０における表面処理用試薬導入口９を持たない構成となっている。図１５は、溝加工した上記電気泳動素子７０における基板７２を溝加工面から見た図である。流路７３は二酸化けい素ガラスによってコートされた流路内壁７４，７５を有する。この流路内壁７４，７５の部分が分離カラムとして働く。図１４，１５中、７１は他方の基板を示し、他の参照符号は、この第５の実施形態の説明まで既に使用されてきた参照符号（図１～図９を含む）のものに準ずる。

【０１１０】〔５－４〕また、図１６に第４実施形態の電気泳動素子５０の変更例である電気泳動素子８０の斜視図を示す。この電気泳動素子８０は、電気泳動素子５０における表面処理用試薬導入口９を持たない構成となっている。図１７は、溝加工した上記電気泳動素子８０における基板８２を溝加工面から見た図である。流路８

３は二酸化けい素ガラスによってコートされた流路内壁８４と窒化シリコンによってコートされた流路内壁８５を有する。この流路内壁８４、８５の部分が分離カラムとして働く。図１６，１７中、８１は他方の基板を示し、他の参照符号は、この第５の実施形態の説明まで既に使用されてきた参照符号（図１～図１１を含む）のものに準ずる。

【０１１１】第５実施形態は、前記第３の実施の形態の変形例、前記第４の実施の形態の変形例と捉えることもできるものである。本発明は、このようにして実施してもよい。

【０１１２】以上の各実施の形態、変形、変更例等に記載された内容は、以下の発明として捉えることもできる。

【０１１３】〔付記項１〕　溝加工した平板を複数重ねて液流路を構成した電気泳動素子において、少なくとも該電気泳動素子にて分離する試料を該分離素子に注入する注入用流路部と、該試料を分離する分離カラム部とが交差して成る電気泳動素子であって、該分離カラム部内面の少なくとも一部分が、該注入用流路部内面のゼータ電位とは異なるゼータ電位の表面を有していることを特徴とする電気泳動素子（第１の実施の形態）。

【０１１４】〔付記項２〕　〔付記項１〕記載の電気泳動素子において、該分離カラム部内面の少なくとも一部分のゼータ電位の値と該注入用流路部内面のゼータ電位の値とが０または同一符号であり、該分離カラム部内面の少なくとも一部分のゼータ電位の絶対値が、該注入用流路部内面のゼータ電位の絶対値よりも小さいことを特徴とする電気泳動素子（第１の実施の形態）。

【０１１５】〔付記項３〕　〔付記項１〕～〔付記項２〕記載の電気泳動素子において、少なくとも該電気泳動素子にて試料を分離する分離カラム部と、分離した該試料を分取する分取用流路部とが交差して成る電気泳動素子であって、該分離カラム部内面の少なくとも一部分が、該分取用流路内面のゼータ電位とは異なるゼータ電位の表面を有していることを特徴とする電気泳動素子（第２の実施の形態）。

【０１１６】〔付記項４〕　〔付記項３〕記載の電気泳動素子において、該分離カラム部内面の少なくとも一部分のゼータ電位の値と該分取用流路部内面のゼータ電位の値とが０または同一符号であり、該分離カラム部内面の少なくとも一部分のゼータ電位の絶対値が、該分取用流路部内面のゼータ電位の絶対値よりも小さいことを特徴とする電気泳動素子（第２の実施の形態）。

【０１１７】〔付記項５〕　〔付記項３〕記載の電気泳動素子において、該分取用流路部を複数有する電気泳動素子であって、少なくとも一つの該分取用流路部が該分離カラム部の任意の位置に構成され、該分取用流路部を境に両端の分離カラム部内面の少なくとも一部分のゼータ電位が、該分取用流路内面のゼータ電位とは異なるゼータ電位の表面を有していることを特徴とする電気泳動素子（第３の実施の形態）。

【０１１８】〔付記項６〕　〔付記項３〕記載の電気泳動素子において、該分離カラム部内面の少なくとも一部分のゼータ電位の値と該分取用流路部内面のゼータ電位の値とが０または同一符号であり、該分離カラム部内面の少なくとも一部分のゼータ電位の絶対値が、該分取用流路部内面のゼータ電位の絶対値よりも小さいことを特徴とする電気泳動素子（第３の実施の形態）。

【０１１９】〔付記項７〕　〔付記項５〕，〔付記項６〕記載の電気泳動素子において、複数の分取用流路部に挟まれた分離カラム部の注入用流路部側に電圧印加用流路部が設けられていることを特徴とする電気泳動素子（第４の実施の形態）。

【０１２０】〔付記項８〕　〔付記項７〕記載の電気泳動素子において、該分離カラム部の任意の位置に構成された該分取用流路部を境に、該分離カラム部内面のゼータ電位の値が異なることを特徴とする電気泳動素子（第４の実施の形態）。

【０１２１】〔付記項９〕　〔付記項８〕記載の電気泳動素子において、該分取用流路部を境に異なる分離カラム部内面のゼータ電位の値が０または同一符号であり、該注入用流路部側に位置する分離カラム部内面のゼータ電位の絶対値が該注入用流路部側とは反対側に位置する分離カラム部内面のゼータ電位の絶対値よりも大きいことを特徴とする電気泳動素子（第４の実施の形態）。

【０１２２】〔付記項１０〕　溝加工した平板を複数重ねて液流路を構成した電気泳動素子において、少なくとも該電気泳動素子にて分離する試料を該分離素子に注入する注入用流路部と、該試料を分離する分離カラム部とが交差して成る電気泳動素子であって、該分離カラム部内面の少なくとも一部分が、溝加工した基板流路内面のゼータ電位とは異なるゼータ電位の表面を有しており、その溝加工した基板のゼータ電位とは異なるゼータ電位の表面が、絶縁性の無機材料によって構成されていることを特徴とする電気泳動素子（第４の実施の形態）。

【０１２３】〔付記項１１〕　〔付記項１０〕記載の電気泳動素子において、該絶縁性の無機材料が、石英硝子やホウケイ酸硝子などの硝子材料、または窒化シリコン、五酸化タンタル、アルミナ、ダイヤモンドからなることを特徴とする電気泳動素子（第５の実施の形態）。

【０１２４】

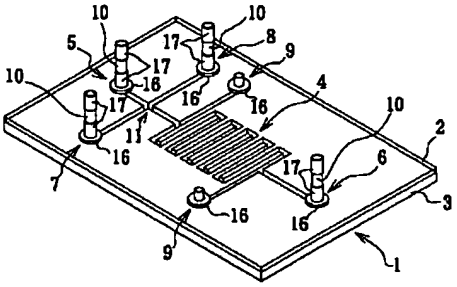
【発明の効果】本発明によれば、高分離・高効率化が可能であって、且つ小型化が可能な機器分析用電気泳動素子を有利に実現することができる。また、耐久性の高い表面修飾内壁を有する機器分析用電気泳動素子を有利に実現することができる。

【図面の簡単な説明】

【図１】　本発明の第１の実施の形態に係る電気泳動素子の斜視図である。

【図２】　同実施の形態での電気泳動素子における溝加工した基板を溝加工面から見た図である。
【図３】　同実施の形態での電気泳動素子の作製方法の一例の説明に供する図である。
【図４】　本発明の第２の実施の形態に係る電気泳動素子の斜視図である。
【図５】　同実施の形態での電気泳動素子における溝加工した基板を溝加工面から見た図である。
【図６】　同例での変更例に係る電気泳動素子を示す図である。
【図７】　同変更例での電気泳動素子における溝加工した基板を溝加工面から見た図である。
【図８】　本発明の第３の実施の形態に係る電気泳動素子の斜視図である。
【図９】　同実施の形態での電気泳動素子における溝加工した基板を溝加工面から見た図である。
【図１０】　本発明の第４の実施の形態に係る電気泳動素子の斜視図である。
【図１１】　同実施の形態での電気泳動素子における溝加工した基板を溝加工面から見た図である。
【図１２】　本発明の第５の実施の形態に係る電気泳動素子の断面図である。
【図１３】　同実施の形態での電気泳動素子における溝加工した基板を溝加工面から見た図である。
【図１４】　本発明の第３の実施の形態に係る電気泳動素子の変更例による電気泳動素子の斜視図である。
【図１５】　同じく、同変更例での電気泳動素子における溝加工した基板を溝加工面から見た図である。
【図１６】　本発明の第４の実施の形態に係る電気泳動素子の変更例による電気泳動素子の斜視図である。
【図１７】　同じく、同変更例での電気泳動素子における溝加工した基板を溝加工面から見た図である。
【図１８】　先行技術の説明に供する電気泳動装置の概略図である。
【符号の説明】
１　電気泳動素子
２　ホウケイ酸ガラス基板
３　ホウケイ酸ガラス基板
４　流路
５　支持液注入口
６　支持液排出口
７　試料注入口
８　試料排出口
９，９ａ，９ｂ，９ｃ，９ｄ　表面処理用試薬導入口
１０　電極
１１　交差部
１２　流路（流路内壁）
１３　レジスト薄膜
１４　溝
１５　ヒーター
１６　コネクター
１７　チューブ
２０　電気泳動素子
２１　ホウケイ酸ガラス基板
２２　ホウケイ酸ガラス基板
２３　流路
２４，２４ａ，２４ｂ　試料分取口
２５　交差部
３０　電気泳動素子
３１　ホウケイ酸ガラス基板
３２　ホウケイ酸ガラス基板
３３　流路
３４　流路（流路内壁）
３５　流路（流路内壁）
４０　電気泳動素子
４１　ホウケイ酸ガラス基板
４２　ホウケイ酸ガラス基板
４３　流路
４４，４４ａ，４４ｂ　試料分取口
４５　交差部
４６　流路（流路内壁）
４７　流路（流路内壁）
５０　電気泳動素子
５１　ホウケイ酸ガラス基板
５２　ホウケイ酸ガラス基板
５３　流路
５４　電圧印加用流路口
５５　流路（流路内壁）
６０　電気泳動素子
６１　ホウケイ酸ガラス基板
６２　ホウケイ酸ガラス基板
６３　流路
６４　流路（流路内壁）
７０　電気泳動素子
７１　ホウケイ酸ガラス基板
７２　ホウケイ酸ガラス基板
７３　流路
７４　流路（流路内壁）
７５　流路（流路内壁）
８０　電気泳動素子
８１　ホウケイ酸ガラス基板
８２　ホウケイ酸ガラス基板
８３　流路
８４　流路（流路内壁）
８５　流路（流路内壁）

【図１】



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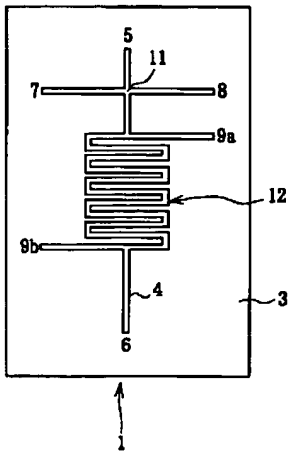

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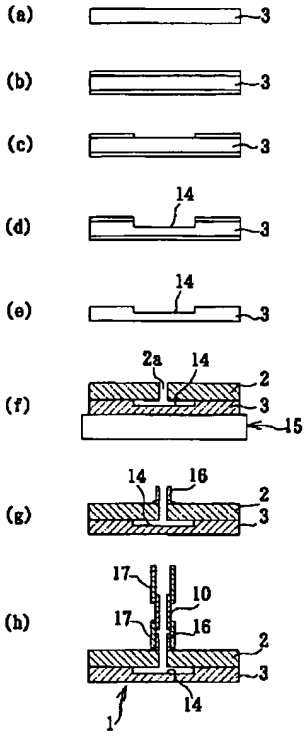

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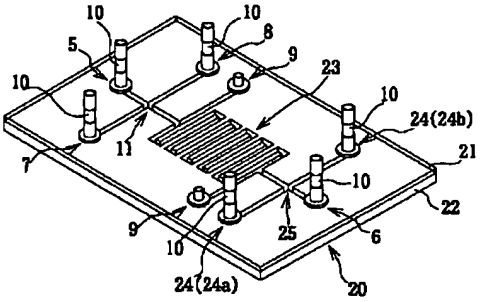

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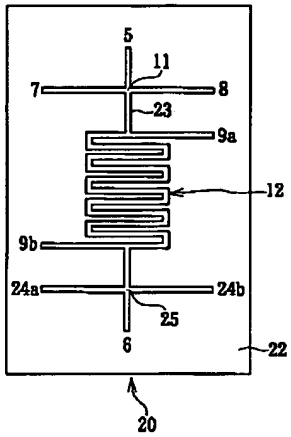

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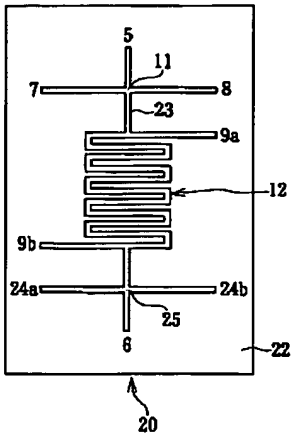

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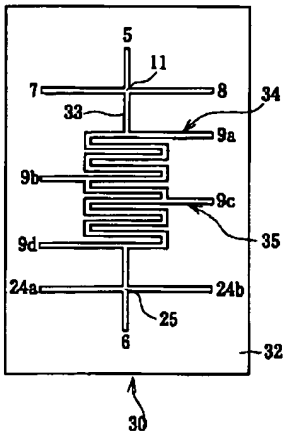

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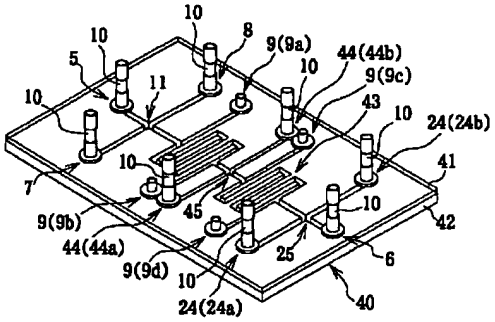

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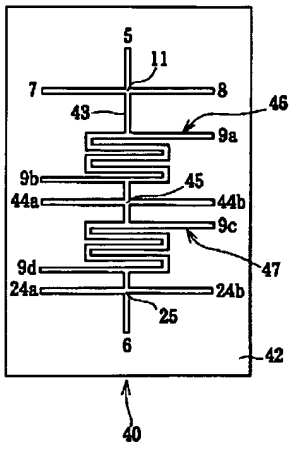
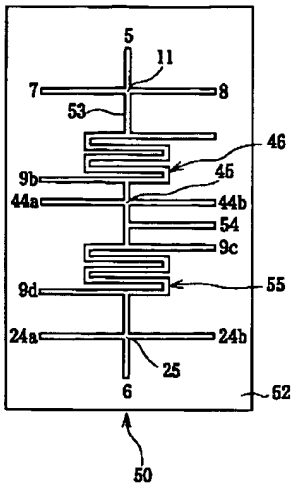


【図１１】



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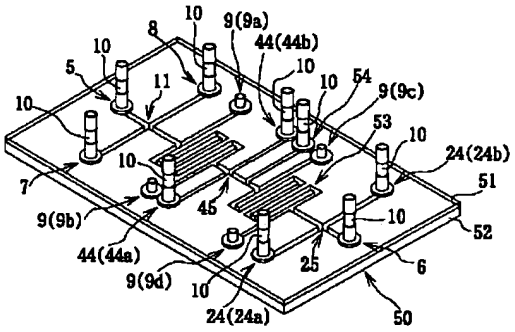

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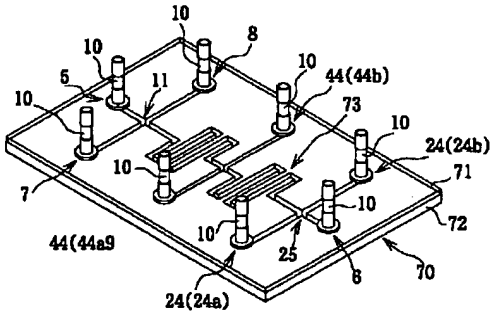

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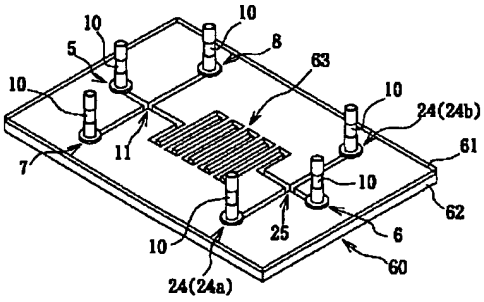

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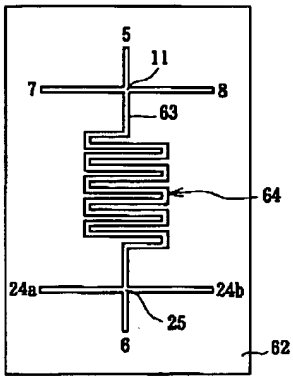

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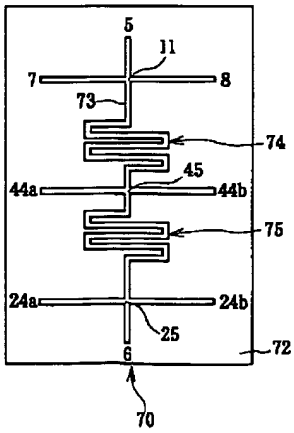
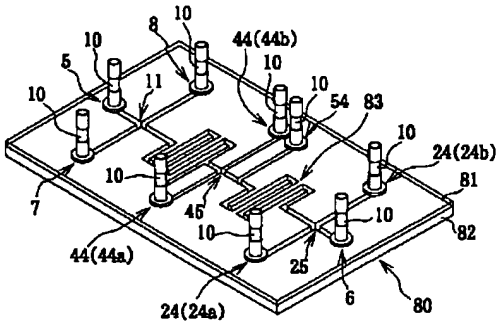
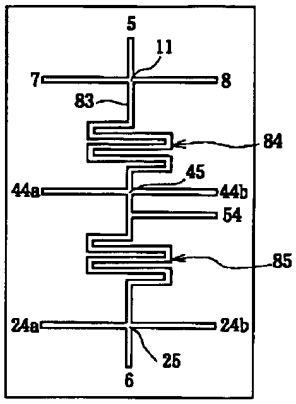


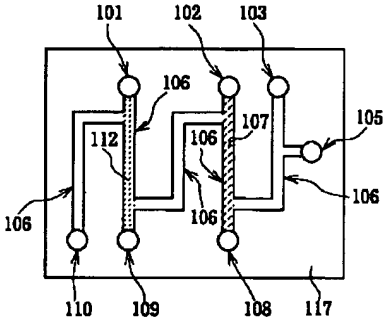
【図１６】


8
10
10
44(44b)
5
10
11
10
10
54
83
10
24(24b)
81
10
7
45
10
10
82
44(44a)
25
6
24(24a)
80

【図１７】


5
11
7
8
83
84
45
44a
44b
54
85
24a
24b
25
6

【図１８】


101
102
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117

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【補正の内容】